A

TREATISE

ON THE

EXTERNAL CHARACTERS

OF

MINERALS.

Patrick Murray

BY

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ADVERTISEMENT.

This treatise contains an Explanation of the External Characters of Minerals and of the language which I have employed in the two first volumes of my System of Mineralogy. The prefixed Tabular View I received from Werner, and published some time ago*, but now incorporate it in this treatise, with the addition of the corresponding terms in German, French, and Latin.

The doctrine of *Oryctometry*, of which Hauy has given so interesting an account in his Treatise on Mineralogy, will be fully illustrated in a subsequent work.

Roslin,
November 20, 1805.

* Tabular View of the External Characters of Minerals, for the use of students of Oryctognosy. 8vo. 1804.

TO

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AND EDINBURGH,

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS,

AND PHYSICIAN TO HIS MAJESTY'S FORCES,

THE FOLLOWING TREATISE

IS INSCRIBED BY HIS FAITHFUL AND

AFFECTIONATE FRIEND

ROBERT JAMESON.

ON THE

EXTERNAL CHARACTERS

OF

MINERALS.

EXTERNAL characters are those which we discover by means of our senses, in the aggregation of minerals.

They are divided into *generic* and *specific*: the generic are certain properties of minerals used as characters, without any reference to their differences, as colour, lustre, weight, &c. The differences among these properties form the specific characters, as adamantine lustre, glassy or vitreous lustre, &c. The generic characters are divided into *general* and *particular*: under the first is comprehended those that occur in all minerals; under the second, those which occur only in particular classes of minerals. The particular generic external characters are arranged according as they strike the senses, and those are placed first which are observable by the eye, not only because they first engage our attention on examining a mineral, but because they are the most numerous and important. To colour follows those observed by touch, smell, and taste.

These preliminary observations were necessary for enabling the reader to understand the subdivisions in the annexed tabular view. We shall now proceed to describe the specific characters and shall begin with colour, because it is the first which strikes the eye, and is one of the most important characters of minerals.

COLOUR.

Before the time of Werner, the colours of minerals were neither defined nor accurately distinguished from one another; he soon, however, saw that this character was of the greatest importance, scarcely yielding to that of chrystallization, and therefore devoted a considerable share of attention to its devellopement. The method he followed in raising this character from its state of neglect was, 1st, To establish a certain number of fixed or standard colours, to which all others could be referred; 2d, To define the varieties and arrange them, according to their resemblance to these standard colours; and 3dly, To place the varieties in such a manner that the whole suite of colóur forms a connected series or circle.

In establishing the fixed or standard colours, he thought he could not do better than adopt those as simple colours, which are considered as such in common life; of these he enumerates eight, which he denominates *chief or principal* colours; they are *white, grey, black, blue, green, yellow, red, and brown.* Although several of these colours are physically compound, yet for the purposes of the oryctognost it is convenient to consider them as simple.

Werner remarks, "I could not here enter into an adop-
" tion of the seven colours into which the solar ray is di-
" vided by the prism as principal colours, nor into the distinc-
" tion of the colours accordingly as they are either simple or

"compound; nor could I omit white and black, the former "being considered as a combination of all colours, and the "latter as the mere privation of light or colour; for these "are distinctions that pertain to the theory of colours among "natural philosophers, and cannot be well applied in com-"mon life, in which black is ranked among the colours as "well as white and yellow; and green, which is mixed, "considered as a principal colour, as well as red, which is "simple.

"In the adoption of the principal colours enumerated "above, I am countenanced by Dr. Schœffer, who has ex-"hibited them with the exception of the grey, in his sketch "of a general association of colour, Regensburg, 1769. I "am, however, justified in adding the grey colour, by ob-"serving, that it occurs very frequently in the mineral king-"dom; that the attempt to bring it under any one of the "other colours would be attended with many difficulties, "and that, if we have respect to denominations, it is con-"sidered in common life as actually differing from the "others." Werner's External Characters, p. 38, 39.

Each of these principal colours contain one which is, oryctognostically considered, pure or unmixed with any other, which is called the *characteristic colour*: thus snow white is the characteristic colour of white; ash grey, of grey; velvet black, of black; Berlin blue, of blue; emerald green, of green; lemon yellow, of yellow; carmine red, of red; and chesnut brown, of brown.

Having thus established eight characteristic colours, he next defined and arranged the most striking subordinate varieties.

The definitions were obtained principally by occular examination, which enables us speedily to detect the different colours of which the varieties are composed. In detailing the result of this kind of *ocular analysis*, if I may use the expression, the predominant component parts are mentioned first, and the others in the order of their quantity. Thus apple green is found to be a compound colour, and we discover by comparing it with emerald green, that it is principally composed of that colour and another, which is greyish white; we therefore define apple green to be a colour composed of emerald green and a small portion of greyish white. The method he followed in arranging the varieties is simple and elegant. He placed together all those varieties which contained the same principal colours in a preponderating quantity, and he arranged them in such a manner, that the transition of the one variety into the other, and of the principal colour into the neighbouring ones, was preserved. To illustrate this by an example. Suppose we have a variety of colour which we wish to refer to its characteristic colour, and also to the variety under which it should be arranged. We first compare it with the principal colours, to discover to which of them it belongs, which in this instance we find to be green. The next step is to discover to which of the varieties of green in the system it can be referred. If, on comparing it with emerald green, it appears to the eye to be mixed with another colour, we must, by comparison, endeavour to discover what this colour is; if it prove to be *greyish white*, we immediately refer the variety to *apple green*; if, in place of *greyish white*, it is intermixed with *lemon yellow*, we must consider it *grass green*; but if it contains neither greyish white nor lemon yellow, but a considerable portion of *black*, it forms *blackish green*. Thus, by mere occular inspection, any person accustomed to discriminate colours correctly can ascertain and analyse the different varieties of colour that occur in the mineral kingdom.

The transition of the principal colours and their varieties into each other he represents by placing the characteristic colours in the middle of a series of which all the members are connected together by transition, and whose extreme links connect them with the preceding and following principal colours. Thus, emerald green is placed in the middle of a series, the members of which pass, on the one hand, by increase of the proportion of blue into the next colour suite the blue, on the other hand, by the increase of yellow into yellow, siskin green forming the connecting link with yellow, and verdegris green with blue.

NAMES OF COLOURS.

The names of the colours are derived, 1st, from certain bodies in which they most commonly occur, as milk white, siskin green, liver brown; 2nd, from metallic substances, as silver white, iron black, and gold yellow; 3d, from names used by painters, as indigo blue, verdegris green, and azure blue; 4th, from that colour in the composition which is next in quantity to the principal colour, as bluish grey, yellowish brown, &c. and 5th, from the names of persons, as Isabella yellow, now called cream yellow.

The principal colours are divided into two series, the one comprehending what Werner terms *bright colours*, the other *dead colours*; red, green, blue, and yellow belong to the first; and white, grey, black, and brown to the second.

We shall now proceed to consider each of the principal colours, and their varieties.

A. WHITE.

a. Snow white is the purest white colour, being free of all intermixture, and is the only colour of this suite which has no grey mixed with it. It resembles new fallen snow. As example of it, we may mention Carrara marble.

b. Reddish white is composed of snow white, with a very minute portion of crimson red and ash-grey. It makes the transition of the white colour to the red. Example, procelain earth.

c. Yellowish white is composed of snow white, with very little lemon yellow and ash grey. Examples, limestone and semiopal.

d. Silver white is the colour of native silver, and is distinguished from the preceding by its metallic lustre. Examples, arnsenical pyrites and native silver.

e. Greyish white is snow white mixed with a little ash grey. Examples, quartz and limestone.

f. Greenish white is snow white mixed with a very little emerald green and ash grey. Examples, amianth, foliated limestone, and amythest.

g. Milk white is snow white mixed with a little Berlin blue and ash grey. The colour of skimmed milk. Examples, calcedony and common opal.

h. Tin white differs from the preceding colour principally in possessing metallic lustre. Examples, native antimony and white cobalt ore.

B. GREY.

Although it is a compound of black and white, yet, for the reasons already mentioned, it is to be considered as simple. It is the colour of completely burnt wood ashes.

a. Lead grey is composed of light ash grey with a small portion of blue, and possesses metallic lustre. It contains the following subordinate varieties.

α. Common lead grey.

β. Fresh lead grey is the preceding variety, with a slight admixture of red. Example, lead glance.

γ. *Blackish lead grey* is common lead grey mixed with a little black. Examples, silver glance and copper glance.

δ. *Whitish lead grey.* This variety passes into tin white. Example, native arsenic.

b. *Bluish grey* is ash grey mixed with a little blue. Examples, hornstone and limestone.

c. *Smoke grey* is ash grey mixed with a little brown. Example, flint.

d. *Pearl grey* is ash grey mixed with a little crimson red and blue, or bluish grey with a little red. It passes into lavender blue. Examples, quartz, procelain jasper, and crystallised hornstone.

e. *Greenish grey* is ash grey mixed with a little emerald green, and has sometimes a faint trace of yellow. It passes into mountain green. Examples, clay slate and potstone.

f. *Yellowish grey* is ash grey mixed with lemon yellow and a minute trace of brown. It passes into yellowish brown and ochre yellow. Examples, calcedony and mica.

g. *Ash grey* is the characteristic colour. Example, quartz.

h. *Steel grey.* Dark ash grey in which there appears sometimes to be a little blue, and has a metallic lustre. Examples, fahl ore, and native platina.

C. BLACK.

It presents fewer varieties than any of the other colours, owing probably to the intermixture of lighter colours not being observable in it. The discrimination of its varieties is attended with considerable difficulty, and can only be satisfactorily accomplished after much practice.

a. *Greyish black* is composed of velvet black and a portion of ash grey. It makes the transition to ash grey. Is very distinct in basalt.

b. *Iron black* is principally distinguished from the preceding variety by its being rather darker, and possessing a metallic lustre. It passes into steel grey. Examples, magnetic iron stone, and iron mica.

c. *Velvet black* is the characteristic colour of this series. It is the colour of black velvet. Example, obsidian.

d. *Pitch black, or brownish black,* is velvet black mixed with a little brown and yellow. It passes into brown. Example, earthy cobalt ochre.

e. *Greenish black, or raven black,* is velvet black mixed with a little brown, yellow, and green. It passes into blackish green. Example, hornblende.

f. *Bluish black* is velvet black mixed with a little blue. It passes to indigo blue, and appears sometimes to contain a slight trace of red. Example, black earthy cobalt ochre.

D. BLUE.

This colour is rarer among minerals than the preceding. Its characteristic colour is Berlin blue; indigo blue connects it with black, sky blue with green; and it is connected with red by violet blue and azure blue.

a. *Indigo blue* is Berlin blue mixed with grey and a little black. Example, blue iron earth.

b. *Berlin blue* is the characteristic colour. It is that of the well known pigment. Example, sapphire.

c. *Azure blue* is Berlin blue mixed with a little red. It is a burning colour. Examples, copper azure and azure stone.

d. *Violet blue* is Berlin blue mixed with much red and a little brown. Of all the blue colours it has the greatest quantity of red; it passes to crimson red. Example, amethyst and fluor spar.

e. *Plumb blue* is composed of Berlin blue with more red than the former colour, a little brown, and an almost imperceptable quantity of black. It passes into cherry red and broccoli brown. Example, spinelle.

f. *Lavender blue* is composed of violet blue with a little grey, or of blue, red, and a little brown and grey. Example, lithomarge.

g. *Smalt blue* is composed of Berlin blue with white, a smaller quantity of grey, and a hardly perceptible trace of red; or of azure blue with grey and white. It passes into milk white. Examples, amethyst and blue iron earth.

h. *Sky blue* is composed of Berlin blue, white, and a little emerald green. It is the dark colour of a clear sky. It is the link which connects the blue and green colours together. Example, turquois.

E. GREEN.

The chief or principal colour is emerald green.

a. *Verdigris green* is composed of emerald green, with much Berlin blue, and a little white. It is the link which connects the green and blue colours together. Examples, copper green and Siberian felspar.

b. *Seladon green* is composed of verdigris green and ash grey. Examples, green earth, Siberian and Brazilian beryll.

c. Mountain green is composed of emerald green, with much blue, and a little yellowish grey; or verdigris green with yellowish grey. It passes into greenish grey. Examples, beryll and hornstone.

d. Leek green is composed of emerald green with a little brown, and somewhat more bluish grey. Examples, nephrite, common actynolite, and prase.

e. Emerald green. The principal or pure unmixed green. All the preceding green colours are more or less mixed with blue, and at length pass into it; but the following part of the green series, by the increasing proportion of yellow, at length passes into yellow. Examples, emerald and fibrous malachite.

f. Apple green is emerald green mixed with a little greyish white. It passes into greenish white. Examples, copper nickel ochre and crysoprase.

g. Grass green is emerald green mixed with a little lemon yellow. The colour of fresh newly sprung grass. Example, uranite.

h. Blackish green is grass green mixed with a considerable portion of black. It passes into greenish black. Example, precious serpentine.

i. Pistachio green is emerald green mixed with a little yellow and a small portion of brown. Example, chrysolite.

k. Asparagus green is pistachio green mixed with a little greyish white; or emerald green mixed with yellow and a little brown. It passes into liver brown. Examples, garnet and oliven ore.

l. Olive green is grass green mixed with much brown; or emerald green with a little yellow and much brown. It passes into liver brown. Examples, garnet and oliven ore.

m. Oil green is emerald green mixed with yellow, brown, and grey; or pistachio green, with much yellow and light ash grey. Examples, fullers earth and beryll.

n. Siskin green is emerald green mixed with much lemon yellow and a little white. It makes the transition to the yellow colour. Examples, uran mica and steatite.

F. YELLOW.

Among the varieties of this species of colour there are three possessing metallic lustre, *viz.* brass yellow, gold yellow, and bronze yellow. The chief colour is lemon yellow; the colours which precede it are yellow mixed with green, and those which follow it are yellow mixed with red. The one side of the series, by the increase of the green, passes by sulphur yellow into green; the other, by the increase of red, passes, by means of orange yellow, into red.

a. Sulphur yellow is lemon yellow mixed with much emerald green and white. Is the colour of natural sulphur. Example, natural sulphur.

b. Brass yellow differs from the preceding colour principally in having a metallic lustre; it contains a small portion of grey. Example, copper pyrites.

c. Straw yellow is sulphur yellow mixed with much greyish white. It passes into yellowish white and yellowish grey. Example calamine.

d. Bronze yellow is brass yellow mixed with a little steel grey, and a minute portion of reddish brown. The colour of bell metal. Example, iron pyrites.

e. Wax yellow is composed of lemon yellow, reddish brown, and a little ash grey; or it may be considered as honey yellow with greyish white. Examples, opal and yellow lead ore.

f. Honey yellow is sulphur yellow mixed with chesnut brown. It passes into yellowish brown. Examples, fluor spar and beryll.

g. Lemon yellow is the pure unmixed colour. It is the colour of ripe lemons. Example, yellow orpiment.

h. Gold yellow is the preceding colour with metallic lustre. Example, native gold.

i. Ochre yellow is lemon yellow mixed with a considerable quantity of light chesnut brown. It passes into yellowish brown. It is a very common colour among minerals. Examples, yellow earth and jasper.

k. Wine yellow is lemon yellow mixed with reddish brown and grey. The colour of Saxon home made wine. Examples, Saxon and Brazilian topaz.

l. Cream yellow, or Isabella yellow, is lemon yellow mixed with greyish white and a little brown and red. It passes into red and brown. Example, bole from Strigau.

m. Orange yellow is lemon yellow mixed with a little carmine red. Example, red orpiment.

G. RED.

a. Aurora or morning red is carmine red mixed with much lemon yellow. Colour of Spanish cresses. Example, red orpiment.

b. Hyacinth red is carmine red mixed with lemon yellow and a minute portion of brown, or aurora red mixed with a minute portion of brown. It passes into brown. Examples, hyacinth and tile ore.

c. *Tile red* is hyacinth red mixed with much greyish white. Example, procelain jasper.

d. *Scarlet red* is composed of carmine red with a very little lemon yellow. Is a well known colour of much intensity. Example, light cinnabar from Wolfstein.

e. *Blood red* is scarlet red mixed with brownish black. Examples, pyrope and jasper.

f. *Flesh red* is blood red mixed with greyish white. Examples, felspar, calc-spar, and straight lamellar heavy-spar.

g. *Copper red.* It scarcely differs from the preceding variety, but in possessing a metallic lustre. It never inclines to blue, which is frequently the case with the flesh red colour. Examples, native copper and copper nickel.

h. *Carmine red* is the principal colour. Example, spinelle, particularly in thin splinters.

i. *Cochineal red* is carmine red mixed with bluish grey. Examples, dark cinnabar and red copper ore.

k. *Crimson red* is carmine red mixed with a considerable portion of blue. Example, ruby.

l. *Columbine red* is composed of carmine red, with more blue than the preceding variety, and what is characteristic for this colour, a little black. Example, oriental garnet.

m. *Rose red* is cochineal red mixed with white. Examples, red ore of manganese and quartz.

n. *Peach blossom red* is crimson red mixed with white. Example, cobalt crust and cobalt bloom.

o. *Cherry red* is crimson red mixed with a considerable portion of brownish black. Examples, spinelle and red antimony.

p. Brownish red is blood red mixed with brown. It passes into brown. Example, clay iron stone.

H. BROWN.

This is one of the darkest colours. The whole species or suite can be distinguished into those which have red and those which have yellow mixed; and between these stands the fundamental colour, the pure unmixed chesnut brown.

a. Reddish brown is chesnut brown mixed with a little red and yellow; or chesnut brown with a small portion of aurora red. Example, brown blende from the Hartz.

b. Clove brown is composed of chesnut brown, cochineal red, and a little black. It is the colour of the clove. It passes into plumb blue and cherry red. Examples, rock crystal, brown hematite, and axinite*.

c. Hair brown is clove brown mixed with ash grey. Example, Cornish tin ore.

d. Broccoli brown is clove brown mixed with ash grey and blue; or brown, red, blue, a little black, and ash grey. It contains also a trace of green. It is a very compounded colour. It passes into plumb blue. Example, zircon.

e. Chesnut brown. Pure brown colour. Example, jasper.

f. Yellowish brown is chesnut brown mixed with a considerable portion of lemon yellow. It passes to ochre yellow. Example, clay iron stone.

g. Pinchbeck brown is yellowish brown with metallic lustre. Rather the colour of tarnished pinchbeck. Example, mica.

* The name axinite is probably to be preferred to that of thumerstone.

h. Wood brown is yellowish brown mixed with much ash grey. It passes into yellowish grey. Example, mountain wood.

i. Liver brown is chesnut brown mixed with olive green and ash grey. It is the colour of boiled, not fresh liver. It passes into olive green. Example, common jasper.

k. Blackish brown is composed of chesnut brown and black. Example, mineral pitch from Neufchatel.

The immense variety of colours that occur in the mineral kingdom, constitute an almost infinite series, to characterise every individual of which is next to impossible. The colours we have already defined, are a few only of the most prominent features of that great and beautiful series, and serve as points of comparison, and as the boundaries between which every occurring colour lies.

From the small number of colours we have defined, and the great variety that occur in minerals, it is evident that the greater number of occurring colours will not correspond exactly with those defined, but will lie between them. It is this circumstance in particular that renders it so difficult to get an acquaintance with colours. To obviate this in some degree, Werner uses terms which express correctly certain prominent differences that are to be observed between every two colours. Thus, when one colour approaches slightly to another, it is said to *incline* towards it (es nährt sich); when it stands in the middle between two colours, it is said to be *intermediate* (es steht in der mitte); when, on the contrary, it evidently approaches very near to one of the colours, it is said to *fall* or *pass* into it; (es geht über).

2. THE INTENSITY OR SHADE OF THE COLOURS.

Each colour can be distinguished according to its relative *intensity*, of which, as expressed in the tabular view, there are four degrees, viz. *dark*, *deep*, *light*, and *pale*. Thus, the principal colours can be divided into four classes, according to their degrees of intensity; black and brown are dark; blue, green, and red, are deep; yellow is light; and white and grey pale. But this distinction, as far as regards the principal colours, may be dispensed with, as they have been already sufficiently discriminated by their division into bright and dead; we should therefore confine it to varieties. Thus, emerald green, violet blue, orange red, &c. may be distinguished according as they are dark, deep, light, or pale.

The intensity of the colour of a fossil depends often on its degree of transparency; for the more trasparent it is, its colour is the paler; and the more opaque, the colour is the darker. Many transparent minerals have therefore a very pale colour, which has caused several mineralogists to describe them as colourless, which, however, is not the case, as their shade of colour is easily detected, by an experienced eye, and it can even be discovered, by comparing the mineral with another, by those who have been little accustomed to such investigations.

The intensity of the lustre has also a considerable effect on the intensity of the colour.

3. TARNISHED COLOURS.

That this character is of importance is evident from its frequent occurrence among minerals, and the attention which Werner has dedicated to its developement.

A mineral is said to be tarnished when it shews on its surface fixed colours different from those in its interior or fracture.

These colours are distinguished, according to their origin, some minerals shewing them,

a. In the bosom of the earth, others

b. On the exposure of the recent fracture to the action of the air.

In those minerals where the tarnish has taken place in the bosom of the earth, no new tarnish takes place on exposure of a fresh fracture to the air, which intimates that this kind of tarnish is produced by a thin covering of some foreign matter, or by the action of percolating fluids. Where a change is induced on a fresh fracture by exposure to the air, it is evidently owing to some chemical change, produced by the agency of the atmosphere. Examples of the first class we have in lead glance, iron glance, and blende; of the second, in native arsenic, magnetic pyrites, and variegated copper ore.

Some minerals are not only changed in their natural repository, but also undergo alteration on exposure to the air, thus combining the two kinds of tarnish. Copper pyrites is an example of this kind.

They are further divided according to their kind. Fossils in whatever manner they receive their tarnish are, *a.* simple, or *b.* variegated. When we say a colour is simple, we mean that one colour predominates over the whole surface; variegated, when the surface shews many different colours that are distinct or run into each other.

Of the merely simple tarnished colours we may mention as examples the following:

α. Grey—glance cobalt.

β. Black—native arsenic.

γ. Brown—magnetic pyrites.

δ. Reddish—native bismuth.

The variegated or party coloured are distinguished according to the intensity of their basis. Of these the following are enumerated in the tabular view.

α. Peacock tail or pavonine tarnish. This is an assemblage of yellow, green, blue, red, and a good deal of brown, on a yellow ground. The colours are nearly equal in proportion, and are never precisely distinct, but always pass more or less into one another. Example, copper pyrites.

β. Rainbow or iridescent tarnish consists of the same colours as the preceding, only green and blue appear to be the principal or predominating colours, and they are on a greyish ground. Example, lead glance.

γ. Pigeon neck or columbine tarnish consists of dull or pale shades of white, red, green, and very little yellow and blue, and much grey, on a white ground, resembling the varied shades of the pigeon's neck. Example, native bismuth.

δ. Tempered steel tarnish consists of pale Berlin blue mixed with a little grey, on a grey ground. Example, iron glance.

4. THE PLAY OF THE COLOURS.

If we look on a fossil which possesses this property, we observe, besides its common colours, others that appear in single small spots, or as it were in coloured sparks. These are generally rainbow colours, and are very clear and burning. They are not steady, but run among each other on every motion of the mineral, or in every different position in which it is placed we observe different colours on the same spot. It occurs in cut diamond and also in opal. It appears to the greatest advantage in sunshine, probably, however, even more beautiful in candle light.

5. THE CHANGEABILITY OF THE COLOURS.

This phenomenon occurs on more places, and in larger spots than the preceding; the colours are mostly simple, but sometimes many occur together, which are, however, distinctly separated, and do not run into each other, nor is the change so rapid as in the appearance called the play of the colours.

We distinguish two kinds of this phenomenon.

A. That which is observed by looking in different positions *on* the mineral, as in Labrador stone.

B. That observed by looking *through it*, as in the common opal, which shews a milk white colour when we look *on* its surface, but when held between the eye and the light is wine yellow.

6. THE IRIDESCENCE.

Here the change of colour is in great patches or parties, and the colours are of the same kind, and are arranged in the same order as in the rainbow, and they are distributed in more or less numerous and broken stripes. It is to be observed by

A. Looking *on* the mineral, as in the variety of calc spar called Iceland or duplicating spar, adularia, beryll, &c. and

B. Looking *through* it, as in rainbow calcedony.

7. THE OPALESCENCE.

This phenomenon depends on a colour, but more particularly on a kind of lustre that shoots from the interior of the mineral. It occurs either in single spots, whose shape appears to depend on that of the mineral, or is star shaped. In the tabular view the first kind is denominated

A. Common opalescence, which is to be observed in cat's eye, sunstone, moonstone, chrysoberyll, and asparagus stone.

The second

B. Stellular opalescence. This is divided into two kinds, the six-rayed and four-rayed: the first occurs in sapphire and oriental ruby; the second in garnet.

8. THE PERMANENT ALTERATIONS.

These must not be confounded with the tarnished colours. The tarnish occurs only on the surface; the permanent alteration, on the contrary, proceeds by degrees through the whole mass of the mineral. Examples of this we have in several minerals. One of the most remarkable is blue iron earth, which, in its natural repository, is said to be greyish white, but, on exposure to the air, becomes throughout of an indigo blue colour. Other instances are fluor spar, cobalt bloom, &c.

9. THE DELINEATIONS OR PATTERNS FORMED BY THE COLOURS.

The distinctions included under this head depend on the shape which the colour assumes. It is only to be observed on simple minerals; therefore, those mineralogists who have attempted to consider it as a character for compound minerals, have deceived themselves. It belongs in general to the individual. The following are the different kinds enumerated and described by Werner.

A. Dotted. In this variety dotts or small spots are irregularly dispersed over a surface which has a different colour from the spots. It occurs frequently in serpentine, but seldom in other minerals.

B. Spotted. If the spots are from a quarter of an inch to an inch in diameter, and the basis or ground still visible, it is said to be spotted. We have examples of it in clay slate and serpentine.

C. Clouded. Here no basis is to be observed, the boundaries of the colours are not sharply marked, and the spots run into each other. It occurs in marble and jasper.

D. Flamed. When the spots are long and arranged according to their length, the flamed delineation is formed. It has still a basis. It occurs in striped jasper, marble, &c.

E. Striped. Consists of long and generally parallel stripes that touch each other and fill up the whole mass of the stone, so that it has no ground. It presents two varieties.

a. Straight striped, as in striped jasper and variegated clay.

b. Ring-shaped occurs in Egyptian jasper.

F. Veined. Consists of a number of more or less delicate veins crossing each other in different directions, so that it is sometimes net-like. We can always distinguish a base or ground. Examples, black marble veined with calcspar or quartz, jasper and serpentine.

G. Dendritic. Represents a stem with branches on a ground. Examples steatite, and dendritic calcedony.

H. Ruiniform. Resembles something broken or ruined, as towns, &c. It occurs only in Florentine marble, which is from this circumstance called landscape marble.

These colour delineations occur most frequently in marble, jasper, and serpentine, and are characteristic of them. They occur seldomer in gyps, flint, calcedony, &c. When delineations occur which cannot be referred to any of those we have defined, we must denominate them according to their shape, from their resemblance to any body or figure.

Many years ago Werner proposed to publish tables of colours, but never had leisure to get them executed. Several of his pupils as Wiedenmann, Estner, Ludwig, &c. have, in their systems of mineralogy, delineated a good many of the principal varieties. Werner, I believe, does not now expect much benefit from such tables, on account of the colours so soon fading; he therefore recommends tables to be prepared by one well acquainted with colours, and to be painted and burnt in enamel.

II. THE COHESION OF THE PARTICLES.

What is meant by the cohesion of the particles of a mineral is understood by every one; we shall here, therefore, only define their different states of aggregation.

Minerals are divided into fluid and solid, and the solid into

A. Solid in a stricter sense, and

B. Friable.

By fluid we understand that state of a body in which its particles alter their place in regard of each other by their own weight; or in which their particles are coherent and likewise moveable one among another. If the molecules of a fossil be both coherent and immoveable, or difficultly moveable one among another, it is said to be solid.

By friable we understand that state of aggregation which can be overcome by the simple pressure of the finger.

PARTICULAR GENERIC EXTERNAL CHARACTERS.

I.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF SOLID MINERALS.

1. THE EXTERNAL ASPECT.

The external aspect of a mineral is that outline or contour which it has received from nature. Thus, if we have a piece of lead glance, as it has been found loose, or imbedded in another mineral, we name the surface which it has received from nature its aspect. All those characters which we can discover by the eye on this outline are denominated the external aspect of the mineral. They are of three kinds. 1. The external shape. 2. The external surface; and, 3. The external lustre.

1. THE EXTERNAL SHAPE

Is divided into four classes,

1. Common
2. Particular
3. Regular
4. Extraneous

} external shape.

All of these classes have their subordinate differences which we shall now describe, and first the

1. *Common external shape.*

By this we understand the most common and most simple kind of shape, and that which has no resemblance to any natural or artificial body, and which is the least definitely defined.

A. Massive, is that common external shape which is from the size of a hazel nut to the greatest magnitude, and whose dimensions in length, breadth, and thickness, are nearly alike. It occurs either imbedded or grown together. Examples, lead glance and copper pyrites.

B. Disseminated, is from the size of a hazel nut until it is scarcely visible. It is either imbedded or implanted. It is divided into

a. Coarsely disseminated, which is from the size of a hazel nut to that of a pea. Examples, copper pyrites and brown spar.

b. Minutely disseminated, from the size of a pea to that of a millet seed. Example, tin stone in granular quartz.

c. Finely disseminated, from the size of a millet seed until it is scarcely visible. Example, brittle silver glance in brown spar.

C. In angular pieces. Minerals having an angular shape, which are found loose, and from the size of a hazel nut and upwards, are said to occur in angular pieces. Of this external shape there are two kinds.

a. Sharp cornered, as in quartz and calcedony.

b. Blunt cornered, as in common opal.

Original angular pieces occur in calcedony, and those formed by attrition in quartz.

D. In grains. Minerals which are usually loose, and not larger than a hazel nut, are said to occur in grains. This shape is distinguished

a. With regard to size, into

α. Large, that is, when they are from the size of a hazel nut to that of a pea. Example, meadow ore.

β. *Coarse*, from the size of a pea to that of a hemp seed. Example, pyrope.

γ. *Small*, from the size of a hemp seed to that of a millet seed.

δ. *Fine*, from the size of a millet seed, until it becomes nearly undistinguishable. Example, platina.

The grains are further distinguishable

b. With regard to the exacter determination of the shape into

α. *Angular grains*, as in iron sand.

β. *Flattish grains*, as in platina.

γ. *Roundish grains*, as in pyrope.

E. *In plates*. Minerals which occur in external shapes, whose length and breadth are very great in comparison of their thickness, and whose thickness is not throughout equal, and is never less than that of the back of a common penknife, are said to occur in plates. The maximum thickness of plates is half an inch. According to the degrees of thickness it is distinguished into

a. *Thick plates*. Example, red silver ore.

b. *Thin plates*. Example, silver glance.

F. *In membranes or flakes*. This shape is distinguished from the former by its thinness, as it never greatly exceeds the thickness of common paper. Its different degrees of thickness are,

a. *Thick*. Example, silver glance.

b. *Thin*. Example, iron pyrites.

c. *Very thin*. Example, copper pyrites on clay slate.

2. *Particular external shape.*

The particular external shape differs from the common external shape, in bearing a resemblance to natural or artificial bodies, and in being far more characteristic and varied in its aspect. It is called *particular*, being not usual or common among minerals, like the common external shape; and peculiarly appertaining to other substances. It is divided into *A. Longish*, *B. Roundish*, *C. Flat*, *D. Cavernous*, and *E. Entangled* particular external shapes. Each of these species have their subordinate varieties which we shall now describe.

A. Longish. Of this the first variety is

a. Dentiform, adheres by its thick extremity, and becomes gradually thinner, incurvated, and at length terminates in a free point, so that it resembles a cutting tooth, whence its name. Its length is from a quarter of an inch to a foot. It is one of the rarer kinds of external shapes, and is peculiar to certain metals. Examples, native silver, and silver glance.

b. Filiform, adheres by its thicker extremity, and terminates by an almost imperceptible diminution of thickness, and is usually curved in different directions. It is thinner and longer than the dentiform. Example, native silver from Himmelsfurst near Freyberg.

c. Capillary. When the filiform becomes longer and thinner, it forms the capillary. It is generally much entangled, and sometimes the threads are so near each other that it passes into the compact. It occurs only in metals, and Werner supposes that it occurs in massive silver, and is the *cause of its malleability*, and of the hackly fracture. Example, native silver.

The three particular external shapes we have just described occur only in native silver and silver glance, scarcely in native gold.

d. Reticulated is composed of many straight threads, which are sometimes parallel and sometimes meet each other at right angles, and form a net-like shape. Examples, native silver in flint, from the mine called Gotthelf. The whole is a series of minute crystals, and is distinguished from the capillary by its threads being always straight.

e. *Dendritic.* In this external shape we can observe a trunk, branches, and twigs, which are distinguished from each other by their thickness, the stem being the thickest. It is divided into the *regular* and *irregular dendritic*; in the first, the branches are set on the trunk, and the twigs on the branches at right angles, or at an angle of 45°; in the irregular the branches proceed from the stem, and the twigs from the branches irregularly, and the shape is not, as is the case with the regular dendritic, a series of crystals. Example, native silver from Mexico. Under this may be reckoned the *featherose* or *plumose* external shape, which has exactly the appearance of a feather. It is a very rare external shape; it occurs in native silver from Mexico.

f. *Coralloidal or coralliform.* When two or three branches, having rounded or pointed extremities, proceed from one stem, the coralloidal external shape is formed. There are usually many stems together. From its resemblance to coral, it is denominated coralloidal. The variety of calc sinter called fios ferri is an excellent example of this kind of particular external shape.

g. *Stalactitic.* A mineral is said to possess a stalactitic external shape when it consists of different straight more or less lengthened rods, which are thickest at their attachment, and become narrower at their free extremity, which is rounded or pointed. Example, calc-sinter.

h. Cylindrical consists of long, rounded, straight, imperforated, usually parallel rods, which are attached at both extremities, and are generally thicker at the extremities than the middle. Examples, lead glance and brown iron stone.

i. Tubiform consists of long, usually single, perforated tubes, which are somewhat longitudinally knotty. Example, calc-sinter.

k. Claviform is the reverse of stalactitic; it is composed of club-shaped parallel rods which adhere by their thin extremities. Examples, brown and black hæmatite.

l. Fructicose. This external shape is formed when many branches issue from a common stem and meet together partywise, so that the whole when viewed from above has a fructicose aspect, not unlike the appearance of colewort. Examples, calc-sinter and brown and black hæmatite.

B. Roundish. To the longish succeeds the roundish particular external shape, which shews less variety, and does not occur so often. The following are the varieties or kinds:

a. Globular. Under this, as mentioned in the tabular view, are comprehended,

α. Spherical, which is again subdivided into perfectly and imperfectly sphœrical; of the perfectly sphœrical we have instances in hornstone, alum slate, and pea ore; of the second, in calcedony.

β. Ovoidal. Example, rounded masses of quartz in pudding stone.

γ. Sphœroidal. When the sphœrical is compressed the spoeroidal is formed. Examples, Egyptian jasper and calcedony.

δ. Amygdaloidal. When the ovidal is compressed the amygdaloidal is formed. Example, zeolite.

b. *Botryoidal* consists of large segments of small balls, which are irregularly heaped together, and have many interstices. It bears a considerable resemblance to grapes, whence its name. Examples, brown and black hæmatite.

c. *Reniform* consists of small segments of large balls, which are so closely set together that no interstices are formed. Examples, red hæmatite, calcedony, and malachite.

d. *Tuberose.* This shape consists of irregular roundish or longish elevations. Example, flint.

e. *Fused-like, or liquiform* *. If we pour lead or any other metal in separate portions on a smooth stone, which is a little inclined, we shall find that each individual portion, when cooled, will have a considerable depression in the middle, such portions resemble very closely the particular external shape called fused-like. It is one of the rarest of the external shapes, and has been hitherto found but in one mineral, that is lead glance; which variety is found in the mine called Alten Grünen Zweig, situated behind the mining village of Erbisdorf near Freyberg.

C. *Flat.* Of this there are only two kinds.

a. *Specular* has on one side, seldom on two opposite sides, a pretty straight smooth shining surface, which is usually irregularly streaked in one direction. Examples, lead glance, copper pyrites, and quartz.

b. *In leaves.* This external shape is composed of thin leaves, which are either regularly curved or straight, and have throughout the same thickness. It is distinguished from the external shape in membranes by the uniformity of its thickness, by its regular

* The term liquiform is used by Mr. Weaver in his translation of Werner's Treatise.

curvatures, by its continuity, (the membraneous external shape being often discontinuous), and its usual adherence by one extremity, shewing that it is a kind of crystalline shoot. It occurs frequently in native gold, but seldom in native silver.

D. Cavernous.

a. Cellular. A mineral is said to be cellular when it is composed of straight or bent tables, which meet together in such a manner as to form empty spaces or cells. It is subdivided into *a. angular,* and *b. circular cellular,* according as the cells are angular or circular.

The angular cellular, or angulo-cellular, is divided into

1. *Hexagonal,* as in quartz, and cellular pyrites.
2. *Polygonal,* as in quartz.

The *circular cellular,* or *circulo-cellular* into

1. *Parallel,* when the cells are in rows, and cylindrical. Example, quartz.
2. *Spongiform.* In this figure, the cells are cylindrical, very small, bent, lying near each other, and disposed in different directions, not parallel as in the preceding. Example, quartz.
3. *Indeterminate.* In this figure the cells have no particular shape, and are of different sizes.
4. *Double circular* or *circulo-cellular,* consists of large flat cells, whose walls are beset with other smaller ones. Example, quartz.

b. With impressions.

a. Cubic, as in quartz and fluor spar.

β. *Pyramidal,* as in hornstone, originating from calc-spar.

γ. *Conical,* as in native arsenic.

δ. *Tabular,* as in quartz originating from heavy spar.

ε. *Globular,* silver glance.

The cubic, pyramidal, and tabular, are formed by imbedded or implanted crystals falling out, leaving empty the space they had formerly filled marked with their figure; but the conical and globular are formed by the deposition of one fossil over another, and the newer taking the place of the older.

c. *Perforated,* consists of long vermicular cavities which occupy but an inconsiderable portion of the mass, and terminate on the surface in small holes. When the holes become very numerous it passes into spongiform. Example, bog iron ore.

d. *Coroded.* A fossil is said to be coroded when it is partywise marked with numerous hardly perceptible roundish spaces. The volume of the spaces is nearly equal to that of the solid of the fossil (basis). It has the appearance of wood which has been gnawed by insects. Example, quartz on lead glance.

e. *Amorphous* is composed of numerous roundish and angular parts that form unequalities, between which there is equally irregular hollows. The whole has the appearance as if a number of small balls and angular pieces were heaped on one another. Example, silver glance and meadow ore.

f. *Vesicular.* When a mineral has distributed through its interior many single, usually round, elliptical, and sphœroidal, also amygdaloidal, or irregular shaped cavities, it is said to be vesicular. The cavities are usually less in volume than the solid part of the mineral. Examples, wacke and lava.

E. *Entangled.* Of this external shape there is but one kind, which is called

a. *Ramose.* It is composed of longish, angular, more or less thick branches which are bent in different directions, but in which no trunk or common stem is to be observed. It probably originates from the greater magnitude of the vesicles in the vescular, the vesicles breaking into each other. Examples, native iron and silver glance.

3. *Regular external shape, or crystallization.*

Every external shape, whose natural contour or outline is composed of a determinate number of planes, which are placed together in a determinate manner, is denominated a crystal.

In describing crystals we have to consider, *A. their genuineness; B. their shape; C. their attachment; D. their magnitude.*

A. The genuineness of the crystals.

This refers to the division of crystals into *true* and *supposititious.* The *true* are the forms which the same substance always assumes, and which are peculiar to it; the *supposititious* are those regular figures whose shape does not depend on the substance of which they are composed, but is owing to pre-existing crystals, or crystal moulds.

Supposititious crystals are formed in two ways.

1. When an imbedded crystal falls out and leaves an empty mould, which is afterwards filled up with fossil matter, a figure or crystal corresponding in shape to the mould is formed. The supposititious crystals formed in this manner are smoother, and have sharp-

er edges and angles than the succeeding kind, and their interior is often hollow and drussy.

2. When over a pre-existing crystal another fossil is deposited, and this crystal is afterwards carried away, a crust is left, which is the second kind of supposititious crystal. It differs from the first kind in having generally a drussy surface and blunter edges and angles.

The first kind of supposititious crystal is a cast or filling of the space formerly occupied by true crystals; the second is merely an incrustation of true crystals.

True and supposititious crystals are distinguished from each other by the following characters:

a. *True crystals.*

α. Have generally a foliated, and sometimes a conchoidal fracture.

β. Are transparent and semitransparent.

γ. Their planes are usually smooth, and sometimes regularly streaked and splendent.

δ. Their angles and edges are sharp.

ε. They form particular characteristic suites.

b. *Supposititious crystals.*

α. Are seldom smooth planed, are never streaked, are commonly rough and drusy, and are scarcely ever splendent.

β. Their angles and edges are not so sharp as in true crystals.

γ. They are usually hollow, and their internal surface is drusy.

δ. They are not like true crystals, connected by transitions with other crystals of the same species, but rather from their figure generally lead to the discovery of the mineral to which they owed their shape. Thus the octahedral crystals of quartz, which originate from fluor spar, do not belong to the suite of quartz.

ε. Even in their internal structure they are different from true crystals; for they seldom present a fracture inclining to foliated.

ζ. Are scarcely ever transparent.

The following are well known instances of supposititious crystals.

1. Octahedral crystals of quartz, originating from fluor spar.
2. Cubic crystals of quartz, from fluor spar.
3. Flint in double three-sided pyramids, from calcspar.
4. Quartz in oblique four-sided tables, from heavy spar.

B. The shape of the crystals.

This is the most characteristic property of crystals, and hence is deserving of our particular attention.

Every shape is composed of planes, edges and angles; but of these it is not necessary to give any exposition, as they are known to every one.

To determine the shape of crystals it is necessary to define the *fundamental figures*, and then their several *modifications.*

The fundamental figure.

Every shape, however complicated, can be reduced to a certain simple one, which is by Werner termed the fundamental figure. In crystals possessing a variety of planes, the fundamental figure may be easily distinguished, by conceiving those planes that lie nearest the center of the crystal, and which are generally the largest, to be extended on all sides until they conjoin. In the fundamental figure are observed and attended to, I. *Its parts.* II. *Its varieties or kinds.* III. *The differences of each fundamental figure in particular.* IV. *The alterations of the fundamental figure.* V. *The division of the planes,* and VI. *The multiplied alterations.*

I. *Parts of the fundamental figures.*

The fundamental figure is composed of *lateral* and *terminal planes* ; of *lateral* and *terminal edges,* and of *angles.*

1. *Lateral planes* are the greatest planes that bound the smallest extent. 2. *Terminal planes* are the smallest planes that bound the greatest extent.

1. *Lateral edges* are formed by the junction of two lateral planes. 2. *Terminal edges* are formed by the junction of a lateral and terminal plane, as in the prism and pyramid; or by the junction of two terminal planes, as in the table.

Angles are formed by the meeting of three or more planes in one point.

II. *The varieties or kinds of the fundamental figure.*

Werner admits seven fundamental figures, *viz. icosahedron, dodecahedron, hexahedron, prism, pyramid, table,* and *lens.*

1. *Icosahedron* is a solid composed of twenty equilateral triangular planes, that meet together under nearly equal angles. Example, iron pyrites.
2. *Dodecahedron* is composed of twelve regular pentagonal planes that meet under equal obtuse angles. Example, iron pyrites.
3. *Hexahedron* is a solid, composed of six quadrilateral planes; it includes the cube and the rhomb. Examples, calc-spar and fluorspar.

4. *Prism* consists of an indeterminate number of quadrangular lateral planes terminated by two equal terminal planes parallel to each other, and having as many sides as the prism has lateral planes. Examples, calcspar and rock crystal.
5. *Pyramid* is composed of an indeterminate number of triangular later planes converging to a point, and of a base possessing as many sides as the figure has lateral planes. The terminal point is called the *summit*, and the flat part the *base*. Example, calcspar.
6. *Table* consists of two lateral planes, equal and parallel, which are bounded by an indeterminate number of terminal planes. Examples, heavyspar and calcspar.
7. *Lens* is composed of two curved planes. Example sparry ironstone.

III. *The differences of each fundamental figure in particular.*

Here we have to determine, 1. *The simplicity.* 2. *Number of planes.* 3. *Proportional size of the planes to one another.* 4. *Angles under which the planes meet.* 5. *Direction of the planes.* 6. *Plenitude, or fulness of the crystals.*

1. *Simplicity.* With respect to simplicity the fundamental figures are either *simple* or *double.* This distinction, however, is confined to the pyramid, as the other six kinds of primitive figures occur simple only.

The simple figure is also distinguished in regard of its position into *erect* or *inverted,* according as it adheres by its basis or its summit. The inverted has hitherto occurred only in calcspar, and is very rare.

In the double figure we have to attend to the placing of the lateral planes; thus the lateral planes of the one pyramid are placed either *straight* or *oblique* on the lateral planes of the other pyramid; or the lateral planes of the one pyramid are set either on the lateral edges or lateral planes of the other.

2. *Number of planes.* The number of planes in the icosahedron, dodecahedron, hexahedron, and lens, is always determinate, but in the prism, pyramid, and table, is indeterminate. In the prism and pyramid, it is only the lateral planes that vary in number, but in the table it is the terminal planes.

The *prism* occurs with three, four, six, (seldom with eight or nine), and twelve lateral planes. The trihedral or three-sided occurs in schorl and tourmaline. The four-sided or tetrahedral prism occurs very often, and we have examples of it in felspar, zeolite, zircon, and heavyspar. The six-sided or hexahedral prism occurs in abundance, and is the most common prismatic crystallization; quartz, emerald, beryll, calcspar, heavyspar, and actynolite afford examples of it. The octahedral prism is a very rare variety of figure, and has hardly been observed in any fossil excepting augite and topaz? The nine and twelve-sided prisms are merely varieties of the preceding figures; the one is formed by the bevelling of the lateral edges of the trihedral prism, the other by the truncation of the lateral edges of the six-sided prism. Emerald affords an example of the twelve-sided, and tourmaline of the nine-sided prism.

The pyramid occurs with three, four, six, and eight sides. The three-sided pyramid is either single or double; of the single we have examples in fahl ore, spinelle, copper pyrites, and many other minerals: examples of the second occur in diamond and calcspar. The four-sided pyramid is the most common, and is almost always double; when it is single the one half is either hid in part or altogether in the matrix; diamond, zircon, fluorspar, and calcspar, are examples. The six-sided pyramid, or hexahedral, occurs also both single and double; of it we have examples in sapphire, calcspar, red silver ore, white lead ore, quartz, and amethyst. The eight-sided is always double and acuminated on both extremities by four planes. Examples of it occur in leuzite, garnet, and silver glance *.

The table has four, six, or eight terminal planes. The existence of a *three*-sided table is still doubtful, the only mineral in which it is said to have been observed is lead glance. The four-sided table occurs frequently, as in heavy spar, white ore of antimony, and yellow lead ore. The six-sided table occur still more frequently, and we have examples of it in mica, calcspar, heavy-spar, and native gold. The eight-sided table occurs in heavyspar and yellow lead ore †.

3. *Proportional size of the planes to one another.* This character is not of very much importance. The planes are either equilateral or unequal; where they are unequal they are either indeterminately or determinately unequal. The determinately unequal planes are, as mentioned in the tabular view, α. alternately broad and narrow; β. with two opposite planes broader; γ. with two opposite plains narrower. We shall illustrate this

* In the pyramid and prism the number of lateral planes is never fewer than three; and, like the table, they never occur with five or seven lateral planes.

† The number of terminal planes in the table can never be fewer than three; it is also worthy of remark that the table has never been observed with five or seven terminal planes.

character by examples drawn from the fundamental figures.

In the hexahedron, dodecahedron, and isocahdron, the planes are alike; when any dissimilarity occurs it is merely accidental, and is therefore indeterminately unequal. The three-sided prism shews only slight indeterminate unequalities. The four-sided prism is not always equilateral, sometimes two opposite planes are broader (the rectangular prism approaching to the table), or two opposite planes narrower; zeolite affords examples of these varieties. The six-sided prism is almost always equilateral; its varieties are generally accidental, excepting the following, which are somewhat characteristic. 1. The two opposite lateral planes broader, as in actynolite and heavyspar. 2. The planes alternately broader and narrower, as in calcspar. The eight and nine-sided prisms afford only accidental or indeterminate varieties, as augite, topaz, and tourmaline.

In the pyramid the only determinate variety is the obtuse octahedron.

The four sided table is usually equilateral, it has sometimes, however, two opposite lateral planes longer than the others; the six-sided table is sometimes unequilateral, or unequal sided, and the eight-sided table is usually longish.

4. *Angles under which the planes meet.* The method employed by Werner, in determining the angles under which the planes of crystals meet, is simple, and enables us merely by the eye, to discover all the varieties of this character which are necessary for the oryctognost *. The terms used to express these varieties are few in

* The minuter investigations of Hauy form a particular mineralogical doctrine distinct from oryctognosie, which is, by Werner, termed oryctometrie.

number and short, so that we can easily recollect them, even in the most extensive suites of crystals, and when accompanied with all the other characters which are necessary for characterising the species. This is undoubtedly a great advantage, as it enables us to retain the conceptions of many species, and thus facilitates the determining of minerals not known to us.

1. In the tabular view, the angles first mentioned, are those formed by the meeting of the lateral planes with one another, which are denominated *lateral edges*, thus applying to the edge the term that belongs to the angles which the planes form with one another, because it is shorter: thus we say acute or obtuse lateral edges, in place of acute or obtuse angles, formed by the meeting of the lateral planes. These lateral edges are either *equiangular*, as in the icosahedron, of which we have an example in iron pyrites; *rectangular*, as in fluorspar; *oblique angular*, as in calcspar; *unequiangular*, as in topaz.

2. The second are the *terminal edges*, or the angles formed by the meeting of the lateral and terminal planes. They are either *rectangular*, as in lead glance; or *oblique angular*, which is either *parallel oblique*, as in the tetrahedral prism of felspar, or *alternate oblique*, as in spinelle, blende, and copper pyrites.

3. The third is the *summit angle*.

The summit angle occurs only in the pyramid.

The angles observable among crystals extend from 10° to 170°, but they seldom reach either extremity of the semicircle. Werner, therefore, subtracts 10° from each extremity, and then divides the remainder into the following subdivisions, to each of which he gives appropriate denominations:

1. Extremely acute is from 10° to 30°.
2. Very acute from 30° to 50°. Example, sapphire.
3. Acute from 50° to 70°. Example, calcspar.
4. Rather acute from 70° to 90°. Example, quartz.
5. Rectangular 90°. Example, zircon.
6. Rather obtuse from 90° to 110°. Example, honeystone.
7. Obtuse from 110° to 130°. Example, calcspar.
8. Very obtuse from 130° to 150°. Example, tourmaline.
9. Extremely obtuse from 150° to 170°.

5. *The direction of the planes.*

The direction of the planes is either *rectilinear* or *curvilinear.*

Rectilinear is the most common, and is the case with almost all the fundamental figures.

Curvilinear planes differ partly by the *position* of the curvature, which is either *concave,* as in fluorspar; *convex,* as in diamond; *concavo-convex,* as in sparry iron-stone; they differ also by the shape being either *sphœrical,* as in brown spar; *cylindrical,* in which the convexity is either parallel with the sides, as in iron pyrites, or parallel with the diagonal, as in fluor-spar; and *conical,* as in gyps, and probably also in lead glance.

6. *Plenitude or fulness of the crystals,* according to which they are either

A. Full, as in almost all crystals.

B. Excavated at the extremities, as in green lead ore.

C. Hollow. Olive green coloured calcspar, from Schemnitz in Hungary, occurs in acute hollow three sided pyramids.

IV. *The alterations of the fundamental figure.*

These are produced by i. *Truncation,* ii. *Bevelment,* and iii. *Acumination.*

i. *Truncation.*

When we observe on a fundamental figure, in place of an edge or angle, a plane that does not belong to it, such a plane is denominated a truncation *.

We have here to observe,

1. *The parts of the truncation.* These are the planes of the truncation, the edges of the truncation, and the angles of the truncation.
2. *The determination of the truncation,* which relates to, 1. *its situation,* as occurring on the edges, or on the angles; 2. *its magnitude,* being either deep or slight; 3. *its setting on or application,* as being straight, or oblique; 4. *the direction of the truncating planes* †, which is either rectilinear, curvilinear, or rounded off.

ii. *Bevelment or cuneature.*

A crystal is said to be bevelled when its edges, terminal planes, or angles, are so altered that in their place we find two smaller converging planes terminating in an edge.

* Werner, in assuming certain fundamental figures, and supposing them variously modified, does not propose to point out the course followed by nature in their formation. He employs a peculiar descriptive language to convey a conception of their forms, not to explain the order of their construction. When he describes a crystal as truncated on its angles or edges, he knows very well that nature does not begin by making a crystal complete, in order afterwards to truncate it more or less on one or other of its parts, he only expresses by this term the appearance the crystal presents to the eye, thus employing a well known term to express an operation of nature which still remains to us a mystery.

† When the truncating plane is equally inclined on all the adjacent planes of the fundamental figure, it is said to be set on straight; but when it is not equally inclined on the adjacent planes it is said to be set on obliquely.

We have here to observe,

1. *The parts of the bevelment.* These are, *A. The planes of the bevelment: B. The edges of the bevelment,* of which there are two kinds: *a.* the proper edge, which is that formed by the meeting of the two bevelling planes; *b.* the edges formed by the bevelling and lateral planes. *C. The angles of the bevelment.*
2. *The determination of the bevelment,* which depends on
   A. The situation of the bevelment, on the terminal planes, on the edges, or on the angles.

Observation. The bevelment occurs generally on the edges, sometimes on the terminal planes, and very seldom on the angles. The cube and three-sided pyramid are sometimes bevelled on the lateral edges, the prism and table on both the terminal and lateral edges, and the octahedron and cube on the angles. Of the bevelment on the angles Werner is acquainted with but three instances, one of these is cubical rock crystal.

B. The magnitude of the bevelment, which is either deep or slight.

C. The angle of the bevelment, which is either obtuse, rectangular, or acute. Here the same scale can be used as that employed for the determination of the summit angle of the pyramid.

D. The uniformity of the bevelment, which is either uniform or broken, and this either *once broken,* as in the double three-sided pyramid of calcspar; or *twice broken,* as in heavy spar.

E. The application of the bevelment.

The application of the bevelment itself is said to be *straight,* when the edge formed by the meeting of the two planes is perpendicular to the axis of the crystal; and *oblique,* when the edge is not perpendicular to the axis of the crystal.

The application of the planes is either on the lateral planes, when an edge is bevelled; or on the lateral edges, when an angle is bevelled.

iii. *The acumination.*

A fundamental figure is said to be acuminated when, in place of its angles or terminal planes, we find at least three planes which converge into a point, and sometimes, but more rarely, terminate in an edge.

We have here, as in the preceding, to observe

1. *The parts of the acumination,* which are *A. the acuminating planes, B. the edges of the acumination,* which are either, *a.* acuminating edges, formed by the meeting of acuminating planes; or *b.* terminal edges of the acumination, which are formed by the terminating of the acuminating planes in an edge or line; *c.* edges formed by the acuminating and lateral edges. *C. The acuminating angles.*
2. *The determination of the acumination,* which depends on observing

   A. The situation of it, either on the angles, or on the extremities.

Observation. The acumination takes place most generally on the angles, sometimes on the terminal planes, and seldom or never on the edges.

B. The acuminating planes, a. their number; the only numbers that occur are *three, four, six,* and *eight, b.* Their proportional magnitude between themselves. This character is of little importance; in quartz and rock crystal the acuminating planes are generally indeterminately unequal, and in heavy spar determinately unequal. *c.* Their shape, which is either determinate, as in hyacinth and calcspar, or indeterminate, as in wolfram. *d.* Their setting on or application, which is either on the lateral planes, as in quartz and zircon, or on the lateral edges, as in garnet and calcspar.

C. *The summit angle,* which is either obtuse, as in prismatic hexahedral garnet; rectangular, as in jargon; or acute, as in calcspar.

D. *The magnitude* according to which crystals are, deeply acuminated, as in cubic crystals of fluorspar, whose angles are acuminated by six planes; slightly acuminated, as in copper pyrites or grey copper ore.

Observation. This alteration is only mentioned when it takes place on angles, or the extremity of the pyramid.

E. *The termination,* as the acumination may terminate in a point or in a line.

In order to form a more distinct idea of truncation, bevelling and acumination, let us take a cube, prism, pyramid, or any other perfect fundamental figure represented in wood, and cut off each of the edges or angles at one stroke, so that in its stead a plane shall appear; this will be truncation. But if the extreme planes, the edges, or the angles of any of these fundamental figures be cut off with two converging strokes, the one from this side, the other from that, so that two planes arise, which, terminating in a line, shall present an edge; this will be bevelling. And if the extreme planes or the angles be cut off at several strokes, all converging together, so that more than two plains arise, commonly terminating in a point, we shall obtain acumination.

V. *The division of the planes.*

Here the number of the planes of the fundamental figure is neither increased nor is their figure changed, as is the case with all the preceding alterations, but each plane is divided into a greater or lesser number of smaller planes that meet together under very obtuse angles.

The number of compartments into which a plane is divided is either two, three, four, or six.

The dividing edges run either parallel to the lateral edges, parallel to the diagonal, or from the center. Of the first we have an example in iron pyrites; of the second in dodecahedral garnet, and of the third in grey copper ore and diamond.

VI. *Multiplied alterations.*

Which occur in certain crystals, and which are either

1. *Co-ordinate,* or
2. *Superimposed.*

Besides the simple alterations of the fundamental figure already described, we very often meet with *multiplied alrations,* that is, where several occur together. In such cases the alterations are said to be *co-ordinate,* when several different kinds of alteration occur together, as truncations and bevellments; and *superimposed,* when several of the same kind are placed on each other, as when one accumination is surmounted by one or more. In describing these alterations we must mention first those which are the largest and the most essential.

Observations. It is often useful to know not only the sum, but also the shape of each species of plane, because it enables us to discover the alliances of the figures, and easily find out their transitions. The links that connect together two fundamental figures unite in their shape the planes of both, and the number of their planes is equal to the sum of both the fundamental figures. Thus the cube has six square planes or faces, and the octahedron eight triangular planes, therefore the intermediate figures possess fourteen planes, of which eight are triangular and six square.

Besides this, in describing crystals, the following may be observed and adjoined.

a. The choice of different modes of describing one and the same crystallization.

Two methods of describing crystallizations are mentioned by mineralogists, the one is called the *representative*, and the other the *derivative*.

If a crystal is described as it appears to the eye at first view, without any reference to its relation to other crystallizations of the same mineral, it is said to be described representatively. But if in the description we attend to its relations with the other crystals of the same mineral, and also to its derivation, it is described derivatively. Thus a description of a prismatic crystallization of tourmaline would be representatively a nine-sided prism, but derivatively a three-sided prism, having its lateral edges bevelled.

The principal or most essential form of a crystallization will be, however, determined by the *larger planes* that lie nearest to the center of the crystal; by the greater or lesser degree of *regularity* of the crystallization, as according with the fundamental figure from which it is supposed to be derived; by the most *frequent occurrence* of the crystallizations of the mineral; by its *affinity* with the other fundamental figures of the same mineral; by the *suitability* and *adaptation* to the alterations which occur in the crystal suite or crystallization; and by the *greater simplicity*.

b. The transition from one fundamental figure into another.

We have occasionally in the foregoing exposition mentioned the transition of crystals into one another; it is now necessary to examine in what manner these transitions originate, how out of one fundamental figure another gradually arises. In the tabular view it is mentioned that those transitions are effected in the following ways.

α. By the newer or alterating planes becoming gradually larger at the expence of certain *previous planes, which are at length totaly obliterated.*

These changes are produced either by truncation, bevelment, or acumination; the transition of the cube into the octahedron is an example of the first; the transition of the octahedron into the icosahedron by the bevelment of the angles of the octahedron of the second; and the third is exemplified by the transition of the tetrahedon into the garnet dodecahedron, by the acumination of each of the angles of the tetrahedron by three planes.

β. Alterations taking place in the proportion of the planes between themselves.

Some planes increase while others diminish, and thus one figure is changed into the other. When the alternate lateral planes of the octahedron become larger, whilst the others diminish a tetrahedron is formed, or the octahedron passes into the tetrahedron.

γ. By the alteration of the angles.

Thus the common dodecahedron, by the increasing obtuseness of its angles, at length passes into the cube.

δ. By convexity.

ε. By the aggregation of crystals.

Thus six sided tables heaped on one another form six sided prisms.

Transitions which originate in this manner form suites of figures, whose extremities are the unaltered fundamental figures. Thus the cube and octahedron are the extremities of the suite of figures that lie between them. It sometimes happens that from one extremity of such a series, we find a transition into another fundamental figure, and from this again into another, and so on, until at last, perhaps, it terminates in the first figure. In this manner are formed what Werner terms *general suites or series* of crystals in opposition to the first which he names *special suites.* We may even imagine a series so universal as to comprehend all known suites of crystals, but of this great series we as yet know but a few links.

It is here of great importance to know that not only the special, but also the general suites of crystals, are characteristic for particular species of minerals. Many instances might be given of this highly interesting Wernerian observation, but the nature of this view, does not permit me to enter into any further detail. We shall now consider the remaining articles connected with the regular external figure.

c. *Obstacles which prevent, or at least render the exact determination of certain crystals, difficult, are occasioned by*

α. *Their obliquity.* When certain planes become very large in comparison of the others, the crystal is *oblique*; so that, at first sight, the acuminating planes may be mistaken for lateral planes, and these again for truncations, as is sometimes the case with rock crystal.

β. *Their incorporation.* When crystals are so deeply imbedded in other minerals that only a few planes are to be observed, they are said to be *incorporated.*

γ. *Their being broken*; and their *too great minuteness.*

It is not difficult to ascertain the figures of perfect crystals; but when they are indistinct their determination is often attended with considerable difficulty. Even in such cases where only a part of the crystal is seen, a knowledge of the number and shape of its planes, the magnitude of the angles under which these planes meet, of the species of mineral and the presumption that the invisible part of the crystal possess the same characters with that which is seen, will facilitate our determination, of these crystals very much. It is evident from this that an extensive acquaintance with the regular figures of minerals, with the number and shape of their planes, even with the angles under which they meet, at least as far as is practised by Werner, and lastly with the transitions of the different fundamental figures, will very materially facilitate the knowing and determination of mineral species.

C. *The attachment of the crystals.*

Werner understands by attachment, the connection of single crystals with massive minerals, and the aggregation of many crystals together. According to the tabular view the first distinction is into

a. Solitary, and this again into *loose, imbedded, and superimposed.*

When a crystal is loose or detached, or only imbedded in earth or sand (consequently in a secondary repository), and has preserved its angles, edges, and planes, or is completely all around crystallised, it is termed *loose.* We have an example of this in small rock crystals from Marmerosch in Hungary.

If a crystal all around crystalised is contained in another mineral, it is said to be *imbedded.* When the crystal is separated from the inclosing mineral, it leaves a smooth impression or mould. Examples of this we have in garnet, imbedded in copper pyrites, and serpentine.

Observation. Such an appearance, as that we have just described, entitles us to conclude that the mass and the included crystal are of cotemporaneous formation.

When a crystal appears to grow as it were out of a massive mineral, and is not included in it, it is said to be *superimposed* or *implanted.* Examples of this we have in silver glance, lead glance, quartz, and grey copper ore from Gersdorf

Observation. Superimposed crystals are of posterior formation to the mineral on which they rest.

The second distinction is into

b. Aggregated. The first distinction of aggregated crystals is where a determinate number *of crystals grow together in a determinate manner, and these differ.*

1. *With respect to number.*
   i. *Pair wise* (twin crystals).
   ii. *Three together* (triple crystals).
2. *With regard to the manner of their intersection.*
   i. *Intersecting one another.*
   ii. *Penetrating one another.*
   iii. *Adhering to one another.*

Twin crystals are formed by two crystals penetrating, intersecting, or adhering to one another. Of the *first* we have an example in felspar, where they penetrate one another in the direction of their thickness; in gyps, where they penetrate one another in the direction of their breadth; and in calcspar, where they penetrate one another in the direction of their length. Of the *second* we have an example in cross-stone; and of the *third* in spinelle.

Of triple crystals, Werner is aquainted with but two instances, the one is spinelle, and the other calcspar.

Observation. Twin crystals occur most frequently in earthy minerals, few have been hitherto discovered in metallic minerals.

The second distinction of aggregated crystals, as mentioned in the tabular view is *where there are many together but merely simply aggregated*; and these are either 1. *on one another;* 2. *side by side,* or adhering laterally to one another; and 3. *promiscuous.*

The *first* occurs principally in tessular crystals, as in lead glance, and calcspar. The *second* occurs in amethyst, where the pyramids or prisms are parallel among themselves. The *third* occurs principally in long and broad figures, as in tables and prisms. We have examples of it in grey ore of antimony, where very long and nearly needle shaped crystals cross one another in different directions; also in tabular crystals, and this kind of tabular aggregation has much resemblance to the cellular external shape.

The third and last kind of distinction of aggregated crystals is where there are *many together, but doubly aggregated.*

This kind of aggregation is distinguished from the foregoing by its forming groupes, that exhibit shapes, resembling bodies in common life. The following are the different kinds enumerated and described by Werner.

i. *Scopiform or fascicular.* Is composed of a number of crystalline needles, that run out from a common center, and form a kind of fasciculus or bundle : Example, calcspar.

ii. *Manipular or sheaf like.* Consists of a number of crystals that diverge towards both ends, and are narrower in the middle, thus resembling a sheaf. Example, radiated zeolite.

iii. *Columnar.* Consists of very long needle shaped prisms, many of which are connected together in the direction of their length, and cross one another in different directions. Example, columnar heavy spar.

iv. *Pyramidal,* is composed of many crystals that are parallel to one another, but of which those in the middle are the highest and the others decline on all sides thus giving to the aggregation a pyramidal shape. Examples, calcspar and amethyst.

v. *Rose-like,* is composed of very thin six sided tables, which are repeatedly curved and so connected together that it resembles a blown rose. It occurs in the variety of calcspar called Rose-spar from Joachimsthal.

vi. *Amygdaloidal,* is formed by tables disposed around each other in such a manner as to form an amygdaloidal shape. Example, heavyspar.

vii. *Bud-like,* is composed of low, (generally) six sided pyramids, one of which is usually situated in the middle, and is surrounded by a number of others, whose extremeties are directed towards one another. Here also many groupes occur together. Example, six sided pyramids of quartz.

viii. *Globular.* Is composed of crystals aggregated into a globular shape. Examples, iron pyrites covered with brown iron stone and flat three sided pyramids of calspar.

ix. *In rows.* This is an aggregation in which the axis of all the crystals lie in one direction, so that it may be considered as a single series, and may be compared with a string of pearls. The flat three sided pyramids of calcspar, and the octahedrons of silverglance afford examples of this kind of aggregation.

x. *Scalarwise,* in which the crystals are arranged like steps of a stair. Example, calc-spar.

The preceeding are all the kinds of the aggregation of crystals hitherto described by Werner, who remarks, however, that there undoubtedly exists many other varieties, which may be described in the manner of those already mentioned.

D. *Magnitude of the crystals.*

a. With regard to their magnitude crystals are divided into

α. Uncommonly large, two feet and upwards in length. The expression intimates that it is rare. Example, rock crystal.

β. *Very large*, from two feet to six inches in length. Examples, rock crystal, quartz, beryl, calc-spar, and felspar.

γ. *Large*, from six inches to two inches in length. It is a very frequent size. Examples, leadglance, garnet, rock crystal &c.

δ. *Middle sized*, from two inches to half an inch. Examples of this magnitude are common, we shall only mention leadglance, iron pyrites, fluor-spar, calc-spar, and garnet.

ε. *Small*, from half an inch to the eight of an inch. Examples fluor-spar, calc-spar &c.

ζ. *Very small*, from the eight of an inch in length, until it is so minute as scarcely to be visible to the naked eye. Examples, native silver, grey copper ore, spinelle &c.

η. *Microscopic*. When crystallised but the form no longer distinguishable by the naked eye. Examples, gold, lead glance &c.

b. *According to the relative greatness of one dimension in comparison with the other, crystals are distinguished into short* and *low*, or *long* and *high* : a prism is said to be long or short, and a pyramid low or high.

When we describe tables we commonly employ the terms *broad* and *longish*, and the terms *thick* and *slender* can be used to express another dimension of the table ; we also say that a prism is thick when it approaches to the tessular shape. Prisms in which the planes are difficultly observable, or in which they are no longer distinguishable : or prisms in which the terminal planes are very inconsiderable in comparison of the lateral planes, are said to be *acicular* and *capillary*

Crystals acuminated at the extremity are said to be *ensiform* or *subulate;* and crystals whose dimensions are nearly alike, as the cube, octahedron, dodecahedron, and icosahedron, are said to be *globular* or *tessular.* It does not include globular aggregations, but only single crystals the number of whose sides are so great that they have a globular figure. Example, diamond &c.

4. EXTRANEOUS EXTERNAL SHAPE.

(PETRIFACTIONS)

Extraneous shapes afford to the oryctognost certain external characters which often assist him in characterising minerals. He has, however only to do with the shape and material of the petrifaction; the determination of the species of animals and vegetables belongs to the doctrine of petrifactions, and their relative situation in the bosom of the earth to the geognost; two investigations most highly interesting, but which we must in this place forbear entering on. We shall at present give only a short sketch of the different heads mentioned in the tabular view.

A. *Petrifactions from the animal Kingdom.*

a. *Quadrupeds.* The remains of quadrupeds are generally found little altered, and in loose detached pieces, as *bones, teeth, horns,* &c. but seldom occur in complete skeletons.

To the celebrated Cuvier we are indebted for the discovery of the remains of many very remarkable quadrupeds. Fujas St. Fond, in his splended work on the hill of St. Peters, near Maestricht, has also communicated much new information. The geognostic relations, of these remains are to be truly and scientifically ascertained by the method of investigation laid down by Werner in his geognosy.

b. Birds. The remains of birds are very rare; some instances have lately occured in the neighbourhood of Mont Martre near Paris.

c. Amphibious animals. Petrifactions of lizards and frogs have been figured and described by naturalists; of the former very fine specimens have been lately discovered by Fujas St. Fond in the Hill of St. Peter near Maestricht; and Werner has observed instances of the latter near Jena in Saxony.

d. Fishes. Of these we find petrified either the *entire fish, skeletons, or teeth.* Of the entire fish instances have been observed in the copper or marle slate of the county of Mansfield; of the skeletons in the limestone of Pappenheim; of the teeth, particularly those of the shark, considerable quantity in the Island of Malta.

e. Insects. These are very rare. The only well authenticated instances of petrified fresh water insects are the larvæ of Libellulæ found in the limestone of Pappenheim. Of sea insects a very considerable variety have been discovered. Of the genus cancer several different species have been found in the Isle of Sheppey in the Medway.

Insects inclosed in amber are not to be regarded as petrifactions, because they are dead bodies nearly unaltered.

f. Shells. Of these many genera are enumerated in the Tabular View; but we shall not at present give any particular description of them, because it is not very intimately connected with oryctognosy, and I intend to treat more fully on this subject in another work. We may remark, however, that the petrifactions belonging to this order are more frequent and abundant than any of the preceeding. It is only their shells which are found, the animals from the great delicacy of their structure, not being capable of petrifaction.

g. *Crustaceous animals.* Of these the most remarkable and abundant are the Echinites, Asterites, Encrinites, and Pentacrinites.

h. *Corals.* Of these a great variety have been observed and many of them are completely different from the species now found on the surface of the earth, and can, according to the observations of Werner, be shewn to be extinct.

B. *From the vegetable kingdom.*

a. *impressions of plants.*

b. *transmuted wood.*

The petrifactions from the vegetable kingdom are not so frequent as from the animal, and are not of so much importance to the oryctognost.

Having finished the section on the external shape, we shall now, in pursuance of the arrangement laid down in the Tabular View, proceed to the consideration of the second generic external character of the external aspect, which is denomiuated

2. THE EXTERNAL SURFACE.

The following are the varieties of this character.

1. *Uneven.* This, of all the kinds of external surface, presents the greatest and most irregular depressions and elevations, yet they are not so considerable as to alter the external shape. We have an example of it in chalcedony.

2. *Granulated.* When the surface is composed of numerous small nearly similar roundish elevations that appear like grains strewed over it, it is said to be granulated. It has a striking resemblance to sha green. It occurs pretty coarse in stalactitic iron stone and pretty fine in reniform hæmatite.

3. *Rough.* This kind of surface is marked with small scarcely visible elevations, which we can hardly discover but by the feel. Example, nodules of quartz.

4. *Smooth.* Here there is no perceptible unequality, and its surface reflects more light than the preceding kinds of external surface. Examples, fluor spar, cubes of lead glance, and the acuminating planes of rock crystal.

5. *Streaked.* This kind of surface is marked with line like elevations and depressions. It is divided into simply streaked and doubly streaked.

A. *Simply-streaked.* This is again divided into

a. *Longitudinally streaked.* When the streaks are parallel with the length of the lateral planes. Examples, topaz, schorl, and beryl.

b. *Transversely streaked.* When the streaks are parallel with the breadth of the lateral planes. Examples, rock crystal, and quartz.

c. *Diagonally streaked.* Where the streaks are parallel with the diagonal of the planes. We have an example of it in the garnet, where the streaks pass through the obtuse angle of the rhomb.

d. *Alternately streaked.* When the transverse and longitudinal streaks occur on alternate planes. It has been hitherto observed only on cubic iron pyrites and red iron stone.

B. *Doubly streaked.*

a. *Pulmiformly.* When the streaks run obliquely towards a principal streak, like the disposition of the parts of a feather. We must be careful not to confound it with the plumose or featherose external shape. Occurs in the variety of bismuth called feather or plumous bismuth.

b. *Reticularly.* This kind of surface appears marked with delicate incisions, which are partly parallel with, and partly intersect each other at right angles. Its incisions distinguish it from the reticulated external shape. The only mineral in which it occurs is grey cobalt ore.

6. *Drusy.* This kind of surface occurs only in crystals. When a crystal is coated with a number of minute crystals of the same kind, so that the new surface acquires a scaly aspect, it is denominated drusy. Examples, iron pyrites and rock crystal.

3. THE EXTERNAL LUSTRE.

This, which is the third generic external character, of the external aspect is more important than the one we have just described. We have to consider the intensity and the sort of lustre.

1. *The intensity of the lustre.* Of this there are five different degrees.

A. *Splendent.* A fossil is said to be splendent when in full day light (not in the sun shine) its lustre is visible at a great distance. The highest degree of this is termed specular splendent. Lead glance, selenite, and iron pyrites, are good examples of this degree of lustre.

B. *Shining.* When a mineral at a distance reflects but a weak light, it is said to be shining. Examples, heavy spar, pitchstone, copper pyrites, and semiopal.

C. *Glistening.* This degree of lustre is only observable when the mineral is near us, and at no greater distance than arm's length. Examples, grey copper ore, porcelain jasper, and splintery quartz.

D. *Glimmering.* If the surface of a mineral, when held near to the eye in full and clear day light, presents a very great number of small faintly shining points, it is said to be glimmering. In strong sun shine it exhibits a kind of play of colour. As

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examples of this degree of lustre, we may mention clay iron stone, red hæmatite, compact lead glanec, and porcelain jasper; and of faintly glimmering, lydian stone is a good example.

E. *Dull.* When a mineral does not reflect any light, or is entirely destitute of lustre, it is said to be dull. Example, clay iron stone and chalk.

2. *The sort of lustre.* Of the different sorts of lustre we cannot give any definition, but must rest satisfied with mentioning a few minerals which present these characters in the greatest perfection.

A. *Metallic lustre,* as in copper pyrites, grey copper ore, and lead glance.

B. *Common lustre.* This comprehends the following varieties:

a. *Semimetallic.* Examples, mica and red hæmatite.

b. *Adamantine*; white lead ore and diamond grains.

c. *Pearly,* as in kyanite, zeolite, and selenite.

d. *Resinous.* Examples, pitchstone, yellow lead ore, and tin crystals.

e. *Vitreous or glassy.* Examples, rock crystal, topaz, &c.

2. THE ASPECT OF THE FRACTURE.

Here we have to observe, 1. The lustre of the fracture 2. The fracture; and 3. The shape of the fragments.

1. THE LUSTRE OF THE FRACTURE.

The internal lustre, or the lustre of the fracture, is the same as the external lustre.

2. THE FRACTURE.

By fracture surface we understand that rent or plane which is produced through the solid (not in the direction of accidental rents, or the natural seperations of the distinct concretions) of a mineral when it is forcibly struck. This definition distinguishes it sufficiently from those accidental rents which are effects of weathering, and from the natural seams that occur in minerals composed of distinct concretions. In examining and describing a fracture, we have only to attend to the surface which is exposed by such a rent as that above described.

This surface is either continuous or undivided, or it shews seperated pieces, and these two include a great variety of subordinate kinds which we shall now describe, following, as usual, the order of the Tabular View.

The first chief kind of fracture is

A. *The compact fracture,* which contains the following varieties.

a. *Splintery.* When, on a nearly even surface, small wedge shaped or scaly parts are to be observed, which adhere by their thicker ends, and allow a little light to pass through, we say that it is splintery. The magnitude of these wedge shaped loosened parts is different, hence Werner divides this fracture into two subordinate varieties, called *coarse splintery* and *fine splintery.* From the above definition, it is evident that this kind of fracture cannot occur in opaque minerals. Examples, hornstone, limestone, and quartz.

b. *Even,* is that kind of fracture surface which shews the fewest unequalities, and these unequalities are flat and their boundaries never sharply marked, on the contrary, run into each other imperceptibly. Minerals possesing this fracture are usually opaque, and have a glimmering lustre. Examples, lead glance, lydian stone, chalcedony and crysoprase.

c. *Conchoidal,* is composed of concave and convex roundish elevations and depressions which are more or less regular: when regular, they are accompanied with concentric ridges, as in many shells; and hence shew a conchoid aspect, from which the denomination is derived. It is distinguished according to the magnitude of the elevations and depressions into *large conchoidal* and *small conchoidal*. The large conchoidal passes into even, and the small conchoidal into uneven. It is further distinguished according to the appearance of the elevations and depressions into *perfect conchoidal*, as in obsidian and opal; and *imperfect conchoidal*, as in porcelain jasper and pitchstone.

Minerals shewing this kind of fracture exhibit almost every degree of transparency, and are usually splendent and shining.

When the small and deep conchoidal loses its roundish shape, it passes into

d. Uneven. This kind of fracture shews the most considerable elevations and depressions, and the elevations are usually angular. These elevations are usually denominated the *grain*; and, according to the size, we have *coarse grained* as in copper pyrites; *small grained*, as in copper nickel; *fine grained*, as in arsenic pyrites.

The small conchoidal passes into the coarse grained, and the fine grained into the earthy. Minerals shewing this fracture are usualy opaque, and their lustre shining and glistning. It occurs principally in metallic minerals.

e. Earthy. When the fracture surface shews a great number of very small elevations and depressions, which make it appear rough, it is called earthy. It is generally accompanied with complete opacity and want of lustre, and appears to be peculiar to earthy minerals. Examples, chalk, and clay iron stone.

f. Hackly. If we break across a native malleable metal, we will observe that its surface consists of small sharp elevations, such a surface is said to be hackly. It occurs only in native malleable metals, and is, consequently, accompanied with metallic lustre and opacity. Examples, native copper, native silver &c.

To conclude our account of the compact fracture, we may remark, that the different kinds often run into each other, and frequently several occur together; in the latter case, the most prevalent fracture is the one which is to be taken as the character of the mineral.

The second chief kind of fracture is

B. *The fibrous fracture,* which is composed of a number of line-like fracture parts.

In this kind of fracture we have to attend to *the thickness, the direction, and the position* of the fibres.

In regard to the *thickness* of the fibres, minerals are said to be *coarse* or *delicate fibrous.* In the *coarse fibrous,* the fibres are of the thickness of a hair; but in the *delicate fibrous,* the thickness is not measureable. Of the first we have examples in gyps, of the second in malachite and amianth.

In regard to the *direction,* fibres are *straight* or *curved.* Of the first we have examples in amianth and hæmatite, and of the second in gyps and common asbest.

The *position* of the fibres is either *parallel, diverging,* or *promiscuous.* The fibres are *parallel* when all continue in one direction, as in amianth; *diverging* when all unite at one extremity in a common center, but at the other, tend to different points. Diverging fibrous is distinguished into *stellular, scopiform* and *promiscuous; stellular,* when the fibres diverge from a common center, like the rays of a star, as in brown hæmatite; *scopiform,* when the fibres are united at one extremity, but diverge towards the other, as in red hæmatite and malachite. The fibres are *promiscu-*

ous when they cross one another in different directions, as in compact plumose antimony.

Minerals possesing a fibrous fracture have usually a glimmering, seldom a glistening or shining lustre; they are opaque or translucent; and, when crystallised, always in capillary crystals.

The third chief kind of fracture is,

C. *The radiated fracture*, which is composed of planes whose breadth is inconsiderable in comparison of their length.

It is distinguished according to the *breadth*, the *direction*, the *position*, the *cleavage*, and the *aspect* of the rays surface.

In relation to the *breadth* of the rays minerals are said to be *uncommonly broad radiated*, *broad radiated* and *narrow radiated*. *Uncommonly broad radiated* when the breadth of the rays is nearly $\frac{1}{4}$ of an inch, as in actynolite and grey antimony ore; *broad radiated* as in actynolite; *narrow radiated* when the breadth is very inconsiderable in comparison of their length, as in cobalt bloom and actynolite; this latter is the link which connects the radiated and fibrous fractures.

The *direction* of the rays is either *straight radiated*, as in actynolite; or *curved radiated*, which may be further distinguished according as the curvature is *transverse* or *longitudinal;* of the first we have an example in kyanite, of the second in actynolite.

The *position* of the rays is either *parallel*, *diverging*, or *promiscuous*. Of the *parallel* wc have examples in hornblende. The *diverging* is divided into *stellular* and *scopiform radiated:* of the first we have examples in cobalt bloom and actynolite, of the second in grey antimony ore. *Promiscous radiated* occurs in grey antimony ore.

The cleavage of the rays. This character will be fully explained under the foliated fracture, as it belongs more properly to it. The cleavage is usually imperfect, and is either single or threefold, and the folia are in the direction of the rays.

The aspect of the rays surface. The surface is either *streaked* or *smooth* ; of the first we have an example in hornblende, of the second in antimony and actynolite.

Minerals with a radiated fracture are seldom dull or glimmering, usually shining and splendent ; commonly opaque or translucent ; and when crystallised the crystals are long and prismatic.

D. *The foliated fracture* is composed of planes whose length and breadth are nearly equal.

It is distinguished according to the *size of the folia*, the *degree of perfection of the foliated fracture*, the *direction of the folia*, the *position of the folia*, *the aspect of the surface of the folia*, and the *cleavage of the folia*.

The *size* of the folia is determined by that of the distinct concretions; we shall therefore defer the particular distinctions until we treat of the distinct concretions.

In regard to the *perfection* of the foliated fracture, it is either *highly perfect* or *specular* foliated, *perfect* foliated, *imperfect* foliated, *slaty*, or *concealed* foliated. The *highly perfect* or *specular* foliated fracture has the most completely smooth planes, and its lustre is specular splendent. Example, lead glance. In the *perfect* foliated the folia are pretty smooth, and shining and splendent, but not in so high a degree as the specular foliated fracture. In the *imperfect* foliated fracture the lustre is intermediate between shining and glistening and the surface is not very even, often indeed rough. Example, fluor spar. In the *slaty* fracture the surface is rough or imperfectly smooth, and is glistening or glimmering. It passes into the compact fracture ; examples of it occur in clay slate and chlorite slate. In the *concealed* foliated fracture the folia appear only on a few places, and they are also imperfect ; it occurs in rock crystal and quartz, but particularly the former.

The direction of the folia is either *straight* or *curved.* Examples of the *straight foliated* we have in selenite and calc-spar. *Curved foliated*—is either *spherical curved*, as in brown spar, and calc-spar; or *undulating curved*, the folia being laid on each other in such a manner, that a transverse section gives a serpentine line, but the longitudinal one a straight line, as in mica; or *floriform foliated*, in which the alternate convexities and concavities shoot out scopiformly from each other, as in lead glance; or *indeterminate foliated*, the folia being curved in an indeterminate manner, as in mica.

The position of the folia is either *common foliated*, in which the folia cover each other completely, as in selenite; or *scaly foliated*, in which the folia cover each other partially, as in mica.

The aspect of the surface of the folia. The surface of the folia is either *smooth* as in selenite; or *streaked* as in hornblende, which is triply streaked.

The passage of the folia, or cleavage is the property which many minerals possess of splitting in certain different directions. It is distinguished

1. *According to the number of the cleavages.* A mineral which splits only in one direction is said to possess a *single cleavage*, and of this we have a good example in mica. The fragments of such minerals are invariably wedge-shaped. When a fossil can be split in two directions it is said to have a *two fold or double cleavage.* Examples, felspar, hyacinth, or hornblende. When a mineral shews a foliated fracture in three different directions, or can be split in three directions, it is said to have a *threefold or triple cleavage.* The folia intersect one another under right angles, or only two of them meet under right angles, or they all intersect each other under more or less obtuse angles. In lead glance and common rock salt we have examples of the first; in heavy spar of the second; in calc-spar and sparry iron-stone of the third. All minerals that shew a foliated fracture in four different directions are said to have a *fourfold or quadruple cleavage;* of this kind of

fracture we have good examples in beryl, fluor spar and iron glance. In beryl three of the cleavages are parallel with the lateral planes, and one with the terminal planes; in fluor spar the folia are parallel with the sides of the octahedron, and in iron glance three of the folia intersect each other under a tetragon angle, and are intersected by a fourth which is parallel with the basis of the three-sided pyramid. When a fossil presents a foliated fracture in six different directions it is said to have *a six fold cleavage.* In the garnet, which shews a six fold cleavage, the folia are parallel with the lateral planes of the garnet dodecahedron; in rock crystal they are parallel with the sides of the six sided pyramid.

2. *According to the angle under which the cleavages intersect one another.* These are to be determined in the same manner and with equal minuteness, as the summit angles of the pyramid.

3. *According to the greater or lesser degree of perfection of each cleavage.* This is determined in the same manner as the perfection of the foliated fracture; but we must be careful to mention which of the cleavages are the most perfect.

Minerals possessing this kind of fracture are usually splendent, sometimes even specular splendent, and shew all degrees of transparency.

When several fractures occur at the same time their relative situation must be observed, as

A. *One including the other, fracture in the great, and in the small.* Of this we have an excellent instance in whet slet, which has in the great a slaty fracture, and in the small a splintery.

B. *One traversing the other, longitudinal and transverse fracture, principal and cross fracture.*

When we know the dimensions of the mineral, that fracture which traverses its greatest length is called the *trans-*

verse, and that which is parallel with its length the *longitudinal*. Thus in topaz we are able to determine the form, consequently the dimensions are ascertained: we say therefore that in topaz the cross fracture is foliated, and the longitudinal small conchoidal. But when we cannot determine the form of the mineral, we denominate the fracture which has the largest surface the *principal* fracture, and that which has the smallest the *cross* fracture. Thus we say that a fragment of gyps is foliated in the principal, but fibrous in the cross fracture.

4. THE SHAPE OF THE FRAGMENTS.

Fragments are those shapes which are formed when a mineral is so forcibly struck, that masses having surrounding fracture surfaces are separated from it*. These fragments are divided into *regular* and *irregular*, in the irregular we observe something analogous to crystals, and they are formed from minerals having a two, three, four or six fold cleavage; but the irregular fragments are composed partly of foliated, partly of radiated and compact parts.

The *regular* are.

1. *Cubic fragments*, which occur in minerals possesing a three fold cleavage, as lead glance and common salt.
2. *Rhomboidal*. Which occur in minerals having a threefold, twofold, or single cleavage. Those that occur in minerals possessing a threefold cleavage, as brownspar, sparry iron stone, calc-spar &c, *are specular on every side*, those that occur in minerals with a double cleavage as felspar, *are specular on four sides;*

* It is not sufficient to say that fragments are those pieces into which a mineral separates in breaking. A mineral composed of distinct concretions, will separate into pieces, but it will often happen that these pieces present no fracture surface, hence are not fragments, but distinct concretions.

and those that occur in minerals having a single cleavage as selenite, *are specular on two sides.*

3. *Trapezoidal.* Occur in foliated coal.
4. *Three sided pyramidal and octahedral* occur in fluor spar, diamond spar and iron glance.
5. *Dodecahedral* occur in minerals possessing a sixfold cleavage, but they are seldom very distinct, owing to the imperfection of the sixfold cleavage. Example, blende.

The *irregular fragments* are

1. *Cuneiform*, which are lengthened pieces thick at one extremity and pointed at the other, and occur in minerals possessing a scopiform radiated fracture, as Cornish tin ore and red hematite.
2. *Splintery.* Occur in fossils having a radiated or fibrous fracture; their length is very considerable in comparison of their thickness and breadth. Example, common asbest.
3. *Tabular.* Occur in fossils having a single cleavage as talc and mica; their length and breadth is more considerable than their thickness.
4. *Indeterminately angular.* The varieties enumerated under this head are very common, and occur principally in minerals possessing a compact fracture. They are distinguished, according to the degree of sharpness which the edges of the fragments possess, into *very sharp edged*, as obsidian and rock crystal; *sharp* edged, as hornstone; *rather blunt edged*, as limestone; *blunt edged*, as gyps; and *very blunt edged.*

3. THE ASPECT OF THE DISTINCT CONCRETIONS.

Distinct concretions are those masses into which certain minerals are naturally divided, and which can be separated from one another without breaking through the solid or fresh part of the mineral. They are separated from one another by natural seams, and frequently lie in different directions. When they are very much grown together, the natural seams are scarcely visible; in such cases, however, they can be distinguished by their different positions and resplendent lustre. They have been confounded with crystals and fragments, from both of which, as is evident from the preceeding definition, they are completely different.

Here we have to consider, 1. The shape of the distinct concretions. 2. The surface of the distinct concretions; and, 3. The lustre of the distinct concretions.

1. THE SHAPE OF THE DISTINCT CONCRETIONS.

It is distinguished into *granular*, *lamellar*, and *columnar*.

1. *Granular distinct concretions*. When a distinct concretion is tessular, or has such a shape that its three dimensions are nearly equal, it is said to be granular. We must be careful, however, not to believe that granular concretions are always or even very frequently round; these are distinguished with regard to *shape*, into

1. *Round-granular*; which are either *spherical-granular* thus approaching pretty near to globular, as in peastone, roe-stone, granular clay iron stone &c.; or *lenticular-granular*, as in red granular clay iron stone.
2. *Angular-granular*, or angulo-granular; which are either *common angulo-granular*, as in lead glance; or *longish angulo-granular*, as in zeolite.

In regard to *magnitude*, into

1. *Large granular*, those which are as large as a hazel nut and upwards. Examples, lead glance, blende, and zeolite.
2. *Coarse granular*, concretions varying from the size of a hazel nut to that of a pea. Examples, leadglance, blende, mica and peastone.

3. *Small granular,* concretions from the size of a pea to that of a millet seed. Examples, lead glance, pea-stone, roe stone and black blende.
4. *Fine granular;* concretions from the size of a millet seed until discoverable with difficulty by the naked eye: it makes the transition into compact, and thus we have a transition from the distinct concretions to the fracture parts. Examples, roe stone, sparry iron stone, lead glance and lime stone.

In lead glance we observe the whole series of magnitudes from large to fine granular; in blende the large, coarse and small granular; in limestone the small and fine granular. This shews how discriminating this character is for certain minerals.

2. *Lamellar distinct concretions,* consist of plates or lamellæ laid one upon another, adhering more or less strongly to each other. They are distinguished with respect to their *direction,* into
1. *Straight lamellar;* which are either *quite straight,* as in heavy spar; or *fortification-wise bent,* as in amethyst.
2. *Curved lamellar;* which are either *indeterminate* curved lamellar as in iron glance; *reniform* curved lamellar, as in native arsenic and brown hematite; *concentric* curved lamellar, which are either *spherical concentric,* as in calcedony, or *conical concentric,* as in calc spar.

With regard to *thickness,* into

1. *Very thick lamellar,* when the concretions exceed half an inch in thickness, as in amethyst, and lead glance from the mine Anna fortuna near Freyberg.
2. *Thick lamellar,* when the thickness varies between half and quarter of an inch, as in amethyst, heavy spar and lead glance.
3. *Thin lamellar,* varying between a quarter of an inch and a line, as in heavy spar.

4. *Very thin lamellar*, varying between a line and a thickness perceptible by the naked eye, as in native arsenic and brown spar.

3. *Columnar distinct concretions* are those in which the breadth and thickness are inconsiderable in comparison of the length. They are distinguished

1. According to their *direction*, into *straight columnar* as in calc spar; and *curved columnar* as in clay iron stone.

2. With regard to *thickness* into *very thick columnar* which are from a half to three quarters of an inch in thickness, as in quartz and calc spar; *thick columnar* one fourth of an inch thick as in calc spar and amethyst; *thin columnar* as in clay iron stone, calc spar and schorl; *very thin columnar* as amethyst, schorl and clay iron stone: It makes the transition into the fibrous.

3. With respect to *shape*, into *perfect columnar*, which is throughout of the same thickness, as calc spar and schorl; *imperfect columnar* in which the columns are thicker in the middle than at the extremities, and sometimes thicker at the extremities than in the middle, as in amethyst and iron glance; *cuneiform columnar*, as in calc spar and quartz.

4. With respect to the *position*, into *parallel columnar* as in quartz and schorlous beryl; *diverging columnar* as in calc spar and clay iron stone; and *promiscuous columnar* as in calc spar and arsenic pyrites.

In several minerals, two of these varieties, or different sizes of the same variety of distinct concretions, occur together, either

a. *One including the other*, as in schorl, where thin prismatic distinct concretions are inclosed in thick prismatic distinct concretions.

b. *The one traversing the other*, as in amethyst, where lamellar distinct concretions traverse prismatic distinct concretions.

2. THE SURFACE OF THE DISTINCT CONCRETIONS.

It will not be necessary to give any explanation of the following kinds of surface, as we explained them when describing the external surface. We shall therefore only give a few examples by way of illustration.

Smooth, as in hematite and heavy spar; *rough* as in clay iron stone; *streaked,* which is either *longitudinally* streaked as in schorl, *obliquely* streaked as in calc spar, or *transversly* streaked as in amethyst; *uneven* as in brown blende.

3. THE LUSTRE OF THE DISTINCT CONCRETIONS.

It is determined in the same manner as that of the external lustre.

4. THE GENERAL ASPECT.

Here we have to observe, 1. The transparency: 2. The streak: and 3. The soiling.

1. THE TRANSPARENCY.

This character presents the five following degrees:

1. When a mineral, either in thick or thin pieces, allows the rays of light to pass through it so completely that we can clearly distinguish objects placed behind it, it is said to be transparent. It is either *simply transparent,* that is, when the body seen through it appears single, as in selenite; or *duplicating,* when the body seen through it appears double, as in calc spar.

Werner observes that calc spar when split into rhomboidal fragments exhibits this phenomenon, but as long as it retains its natural surface, objects seen through it appear only single. Many explanations have been given of this duplicating property, but the detail of them belongs to the natural philosopher.

2. *Semitransparent.* When objects can be discerned with difficulty through the fossil, and then always as if seen through a cloud. Examples, chalcedony, common and precious opal, and carnelian.

3. *Translucent.* When the rays of light penetrate into the mineral and illuminate it, but objects cannot be observed either through thick or thin pieces, it is said to be translucent. Examples, pitchstone, quartz, and granular limestone.

4. *Translucent on the edges.* When light shines through the thinnest edges and corners, or when the edges are illuminated in the same degree as the whole mineral in the immediately preceeding variety of transparency. It is said to be translucent on the edges. Examples, hornstone and heliotrope.

5. *Opaque.* When even on the thinnest edges of a mineral no light shines through, it is said to be opaque, as in chalk &c.

2. THE STREAK.

The streak is that character which is presented to us when a mineral is scraped with the point of a knife. The colour of the streak is either *similar* when the powder which is formed has the same colour as the mineral, as in chalk; or *dissimilar* or *different* from that of the mineral. Here we must attend not only to the kind of colour, but must observe whether or not the lustre of the mineral is destroyed or heightened, or if it produces a lustre in minerals that have none. We shall illustrate this by a few examples. Cinabar has a crimson red colour, but yields a scarlet red streak; red orpiment is aurora red, but yields an orange yellow streak; iron glance has a steel grey colour, but gives a cherry red streak. Malleable metals, as native gold, native silver, &c. have their lustre increased by the streak.

3. THE SOILING.

When a mineral taken between the fingers, or drawn across another body, leaves some particles, or a trace, it is said to soil or colour. It soils either *strongly*, as chalk and mountain soap; or *slightly*, as molybdæna, lead glance, and graphite. Besides this, there are three other distinctions connected with this character to be attended to. *Some minerals soil but do not write*, as iron froth: others *write but do not soil*, as molybdæna and mountain soap; and others *both write and soil*, as graphite, drawing slate and chalk.

Having now finished the explanation of those external characters which are observable by sight, we proceed to those which are discoverable by the touch and the hearing.

5. CHARACTERS FOR THE TOUCH.

Here we have to observe, 1. The hardness: 2. The tenacity: 3. The frangibility: 4. The flexibility, and 5. The adhesion to the tongue.

1. THE HARDNESS*. The degrees are

1. *Hard.* When a mineral gives sparks of fire plentifully when struck with the steel, but is not in the least affected by the knife, it is said to be hard. It is further distinguished according as it is more or less affected by the file; 1. *resisting the file*, even acting on it, or hard in the *highest degree*, as diamond, sapphire and emery; 2. *yielding a little to the file*, or hard in a *high degree*, as topaz, beryl, rock crystal &c; 3. *yielding to the file*, as chrysolite, garnet &c.

* The four principal kinds of hardness are ascertained by the steel, or a properly tempered knife; but for the more accurate determination of the higher degrees Werner employs a file, and for the lower, that is, soft minerals, the nail of the finger.

Semihard. When a mineral gives a very few sparks with steel, and is with difficulty touched by the knife, it is said to be semihard, as pitchstone, basalt, blende, and grey copper ore.

3. *Soft.* When a mineral is easily cut by the knife, and also yields to the nail of the finger, it is said to be soft, as natural sulphur and gyps.

Observations. In examining the hardness of minerals we must be careful to attend to the following circumstances:

1. Not to confound the real hardness of the mineral with accidental hardness, which latter is caused by the intermixture of hard parts in soft minerals, and soft parts in hard minerals.
2. When minerals are composed of distinct concretions which are not very closely joined together, we must not give the hardness of the aggregate for that of the mineral, because the hardness in such cases must be taken from that of the individual concretions.
3. And we must be careful that the mineral whose hardness we wish to ascertain, is not in a state of decomposition.

2. THE TENACITY.

By tenacity is understood the relative mobility or the different degrees of cohesion of the particles of minerals. There is a series from the coherent and completely immoveable to the coherent and moderately moveable, which latter is expressed by malleability, and is the greatest degree of the mobility of the particles observed among solid minerals. This series continues through different kinds of fluid minerals, and the greatest degree of the mobility of the particles, without coherence, is found in rock oil. The degrees of tenacity are,

1. *Brittle.* A mineral is said to be brittle, if on cutting it with a knife, the particles fly away with a noise, and leave a rough surface which has less lustre than

the fracture. In this degree of tenacity, the particles are completly immoveable. Examples, quartz, heavy spar, and grey copper ore.

2. *Sectile or mild.* On cutting minerals possessing this degree of tenacity, the particles lose their connection in a considerable degree, but this takes place without noise or much springing. Some minerals possessing this property can be sliced, and leave a smooth surface. Examples, lead glance, copper glance, and native arsenic.

Ductile. Minerals possessing this degree of tenacity can be cut into slices with a knife, extended under the hammer, or drawn into wire of considerable length by the application of a greater or lesser degree of weight. The particles are more or less moveable among themselves, without losing their connection. Examples, native gold, native silver, and native iron.

3. THE FRANGIBILITY.

By frangibility is understood the resistance which minerals oppose when we attempt to break them. It must not be confounded with hardness. Quartz is hard, and hornblende soft, yet the latter is much more difficultly frangible than the former. The degrees of frangibility are the following: 1. *Very difficultly frangible,* which occurs principally in malleable minerals, as gold, silver, &c. 2. *Difficultly frangible,* as basalt, and native arsenic. 3. *Not particularly difficultly frangible* or *rather easily frangible,* as flint, chalcedony, and quartz; 4. *Easily frangible.* 5. *Very easily frangible,* as straight lamellar heavy spar, lead glance, and common and precious opal.

4. THE FLEXIBILITY.

This term expresses the property possessed by some minerals of bending without breaking. Flexible minerals are either *elastical flexible*, that is, if when bent they again spring back into their former direction, as mica; or *common flexible*, when they can be bent in different directions without breaking, and remain in the direction in which they have been bent, as molybdena, gyps, and talc. Native copper, native silver and amianth appear to hold the intermediate place between elastical flexible and common flexible.

5. THE ADHESION TO THE TONGUE.

This character occurs only in such minerals as possess the property of absorbing moisture, which causes them to adhere to the tongue. It occurs principally in soft and very soft minerals; it is not known in hard minerals, and there is but one instance of its occurrence in semihard minerals, that is, in the variety of semiopal called oculus mundi. The degrees of adhesion are *strongly adhesive*, as meerschaum, and oculus mundi; *pretty strongly* adhesive as bole; *somewhat* adhesive, as clay slate; a *little adhesive*, as pipeclay; and *not at all adhesive*, as quartz, steatite, &c.

6. CHARACTERS FOR THE HEARING.

THE SOUND.

The different kinds of sound occurring in the mineral kingdom are the following: 1. *a ringing sound*, that is, a clear sound, as that of native arsenic, and thin splinters of hornstone. Specimens to possess this property in full perfection, should have one dimension, as length and breadth, greater than the thickness. 2. *A grating sound*, which is a very weak rough sound, resembling that of dry wood or fresh burnt clay, and is produced when the finger is drawn quickly across certain minerals, as mountain cork and mealy zeolite. 3. *A creaking sound*, which is a harsh sharp sound, as that of natural amalgam.

Having finished the explanation of the characters that are presented by solid minerals, we shall now give an account of those which occur in friable and fluid minerals. These are very few in number, because few fluid or friable minerals occur in nature.

IId.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF FRIABLE MINERALS.

1. THE EXTERNAL SHAPE.

It is either *massive*, as porcelain earth, and heavy spar; *disseminated*, as blue iron earth; *thinly coating*, as red iron froth; *spumous*, as brown iron froth; and *dendritic*, as brown iron froth.

2. THE LUSTRE.

It is determined in the same manner as in solid minerals. Friable minerals occur only *glimmering* or *dull:* the glimmering is either *common* glimmering, as in indurated cobalt ochre, *metallic glimmering*, as in iron froth, or *pearly* glimmering, as in earthy talc; the *dull* occur in earthy cobalt ochre.

3. THE ASPECT OF THE PARTICLES.

The particles of friable minerals appear in some instances like dust, so that we can with difficulty distinguish by the naked eye any dimensions; these are called *dusty particles*, and occur in cobalt crust, blue iron earth and porcelain earth; in others two dimensions can be observed, and they appear foliated, and these are called *scaly particles*, and occur in brown and red iron froth, earthy talc and chlorite earth.

4. THE COLOURING OR SOILING.

Minerals colour either *strongly*, as iron froth and porcelain earth; or *slightly* as cobalt ochre and chlorite earth.

5. THE FRIABILITY.

Friable minerals are either *loose*, that is, when the particles have no perceptible coherence, as blue iron earth; or *cohering* in which the particles are slightly connected together, as cobalt crust.

IIId.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF FLUID MINERALS.

As there are only two species of fluid minerals, we have but little to say respecting their characters.

1. *The lustre* is either *metallic* as in mercury; or *resinous* as in rock oil.
2. *The transparency.* The following are all the degrees necessary for the purposes of discrimination. 1. *transparent* as in naptha 2. *troubled* or *turbid* as in mineral oil: and 3. *opaque* as in mercury.
3. *The fluidity.* Here we have only two degrees to observe. 1. *fluid* as in mercury and mineral oil, and 2. *viscid* as in mountain tar.

REMAINING GENERAL GENERIC EXTERNAL CHARACTERS.

4. THE UNCTUOSITY.

In relation to which minerals are distinguished into *meagre* and *greasy*. The former are those in which, by handling, a certain degree of greaseness is to be observed: the latter (which are the most common) are those in which greasiness is not to be observed in handling them. Minerals may be further distinguished in relation to unctuosity into such as are, 1. *rather greasy*, as lithomarge, 2. *greasy*, as talc; 3. *very greasy*, as mineral oil. This property occurs only in soft and friable minerals.

5. THE COLDNESS.

When different kinds of minerals, all having equally smooth surfaces, are exposed for some time to the same temperature, we find by feeling them that they possess different degrees of cold. To use this character with precision much practice is required; but those who have accustomed themselves to it, are able, by the mere feel, to distinguish serpentine, gyps, porphyry, alabaster, agate, &c. from one another, and can also distinguish artificial from true gems. It is however, principally useful in determining polished specimens. The different degrees mentioned in the Tabular View are,

1. *Cold.* Examples, basalt, agate and porphyry.
2. *Pretty cold.* Examples, limestone, serpentine and gyps.
3. *Rather cold.* Examples, rock salt and amber.

6. THE WEIGHT.

This like most other external characters, is determined without the aid of any instrument; in some cases indeed, as in precious stones and some of the metals, it may be necessary to use a hydrostatic ballance, but this is rather a rare occurrence. It is not to be concealed that much practice is required to be able to determine the relative gravity by the feel, the method practised by Werner, but, when once acquired, it saves much time, by precluding the necessity of a continual recurrence to the ballance.

The degrees of the specific gravity of minerals are the following.

1. *Swimming or supernatant,* which comprehends all minerals under 1000, water=1000. Example, mineral oil.
2. *Light,* from 1000, to 2000. Examples, amber, sulphur, and black coal.

3. *Not particularly heavy, or rather heavy,* from 2000 to 4000. Examples, quartz, flint and chalcedony.
4. *Heavy,* from 4000 to 6000. Examples, heavy spar copper pyrites, and iron pyrites.
5. *Uncommonly heavy,* all above 6000. Examples, native metals, as gold, silver &c; ores as lead glance, tin stone &c.

The first and second degrees, which comprehend the swimming and light minerals, contain all the inflammable minerals; the third, with a few exceptions, all the earthy minerals; the fourth, the greater number of the ores: and the fifth, the native metals and a few ores.

7. THE SMELL.

Of this we can give no definition, and shall therefore illustrate it by the minerals in which it occurs.

It is observed either when

1. *Spontaneously emited,* in which case it is
   a. *Bituminous,* as mineral oil, and mineral pitch.
   b. *Faintly sulphureous,* as natural sulphur.
   c. *Faintly bitter,* as radiated grey antimony ore.
2. *After breathing on it,* in which a *clayey like smell,* as in hornblende and chlorite, is produced.
3. *Excited by friction.*
   a. *Urinous,* in stink stone.
   b. *Sulphureous,* in iron pyrites.
   c. *Garlick like* or *arsenical,* in native arsenic, and arsenic pyrites.
   d. *Empyreumatic,* in quartz and rock crystal.

8. THE TASTE.

This character occurs principally in the saline class, for which it is highly characteristic.

The varieties of it are

1. *Sweetish taste,* common salt.

2. *Sweetish astringent,* natural alum and rock butter.
3. *Styptic,* natural vitriol.
4. *Saltly bitter,* natural bitter salt.
5. *Saltly cooling,* nitre.
6. *Alkalinc,* natural soda.
7. *Urinous,* natural sal-ammoniac.

FINIS.

EXPLANATION OF THE PLATES.

Fundamental Figures.

FIG. 1. The Icosahedron.
2. The Dodecahedron.
The Hexahedron, as
3. Cube.
4. Rhomb.
5. Rectangular-tetrahedral prism.
6. Oblique-angular tetrahedral prism.
7. Oblique-angular tetrahedral prism, in which the terminal planes are set obliquely on the lateral planes.
8. Equiangular-hexahedral prism.
9. Tetrahedron, or simple three-sided pyramid.
10. Double three-sided pyramid, in which the lateral planes of the one pyramid are set on the lateral edges of the other.
11. Octahedron.
12. Simple six-sided pyramid.
13. Double six-sided pyramid, in which the lateral planes of the one pyramid are set on the lateral planes of the other.
14. Double six-sided pyramid, in which the planes of the one pyramid are set obliquely on those of

the other, so that the common base forms a zig zag line.

Fig. 15. Rectangular four-sided table.

16. Oblique-angular four-sided table.

17. Equiangular six-sided table.

18. Lengthened six-sided table.

19. and 20. Common lens.

Alteration of the Fundamental Figures By Trnucation.

21. Cube truncated on all its angles.

22. Cube truncated on all its edges.

By Bevclment.

23. The cube bevelled on all its edges.

24. Three-sided prism having its lateral edges bevelled.

25. Oblique-angular four-sided prism bevelled on its extremities.

26. Six-sided table, with bevelled terminal planes.

27. Octahedron, with bevelled angles.

By Acumination.

28. Cube, with the angles acuminated by three planes which are set on the lateral planes.

29. Cube, with the angles acuminated by three planes which are set on the lateral edges.

30. Rectangular four-sided prism acuminated by four planes, which are set on the lateral planes.

31. Equiangular six-sided prism, acuminated on both extremities by six planes, which are set on the lateral planes.

FIG. 32. Four-sided prism, acuminated on both extremities by four planes, which are set on the lateral edges.

33. Six-sided prism, accuminated on both extremities by three planes, which are set on the alternate lateral planes.

34. Six-sided prism, acuminated on both extremities by three planes, which are set on the alternate lateral edges.

35. Double eight-sided pyramid, accuminated on both extremities by four planes, which are set on the alternate lateral edges.

ERRATA.

PAGE 6, line 10, *for* arfenical pyrites *read* arfenic pyrites,

9, line 29, *for* feladon *read* celadon.

13, line 19, *for* principal colour *read* characteriftic colour.

14, line 7, *for* fundamental colour *read* characteriftic colour.

29, line 13, *for* Fructicofe *read* Fruticofe.

37, line 3, *for* later *read* lateral.

TABULAR VIEW

OF THE

DIFFERENT GENERIC AND SUBORDINATE SPECIAL EXTERNAL CHARACTERS

OF

MINERALS.

GENERAL GENERIC EXTERNAL CHARACTERS.

1. *The different chief or principal colours and their varieties.*
   A. *White.* Weiſs. Blanc. Albus.
      a. *Snow white.* Schneeweiſs. Blanc de neige. Niveo-albus.
      b. *Reddiſh white.* Röthlichweiſs. Blanc rougeatre. Rubeſcenti-albus.
      c. *Yellowiſh white.* Gelblichweiſs. Blanc jaunatre. Flaveſcenti-albus.
      d. *Silver white.* Silberweiſs. Blanc d'argent. Argenteo-albus.
      e. *Greyiſh white.* Graulich-weiſs. Blanc griſatre. Caneſcenti-albus.
      f. *Greeniſh white.* Grünlich-weiſs. Blanc verdatre. Virideſcenti-albus.
      g. *Milk white.* Milchweiſs. Blanc de lait. Lacteo-albus.
      h. *Tin white.* Zinnweiſs. Blanc d'etain. Stanneo-albus.
   B. *Grey.* Grau. Gris. Griſeus.
      a. *Lead Grey.* Bleigrau. Gris de plomb. Plumbeo-griſeus.
         α. *Common lead grey.* Gemeines bleigrau.
         β. *Freſh lead grey.* Friſches bleigrau.
         γ. *Blackiſh lead grey.* Schwärzlich bleigrau.
         δ. *Whitiſh lead grey.* Weiſslich bleigrau.

b. Blueiſh grey. Bläulichgrau. Gris bleuatre. Cærulefcenti-grifeus.

c. Pearl grey. Perlgrau. Gris de perle. Margaritino-grifeus.

d. Smoke grey. Rauchgrau. Gris de fumée. Fumofo-grifeus.

e. Greeniſh grey. Grünlichgrau. Gris verdatre. Viridefcenti-grifeus.

f. Yellowiſh grey. Gelblichgrau. Gris jaunatre. Flavefcenti-grifeus.

g. Steel grey. Stahlgrau. Gris d'acier. Chalybeo-grifeus.

h. Aſh grey. Afchgrau. Gris de cendre. Cinereo-grifeus.

C. *Black.* Schwarz. Noir. Niger.

a. Greyiſh black. Graulichfchwarz. Noir grifatre. Canefcenti-niger.

b. Iron black. Eifenfchwarz. Noir de fer. Ferreo-niger.

c. Velvet black. Sammet fchwarz. Noir de velours. Atro-niger.

d. Pitch black, or browniſh black. Bräunlichfchwarz. Noir brunatre. Brunefcenti-niger.

e. Raven black, or greeniſh black. Rabenfchwarz oder grünlich fchwarz. Noir verdatre. Viridefcenti-niger.

f. Blueiſh black. Bläulichfchwarz. Noir bleuatre. Cærulefcenti-niger.

D. *Blue. Blau. Bleu. Cæruleus.*

a. Indigo blue. Indigblau. Bleu d'indigo. Indico-cæruleus.

b. Berlin blue, or Pruſſian blue. Berlinerblau. Bleu de Pruffe. Berolino-cæruleus.

c. Azure blue. Lazurblau. Bleu d'azur. Azureo-cæruleus.

d. Violet blue. Veilchenblau. Bleu violet. Violaceo-cæruleus.

e. Plumb blue. Pflaumenblau. Bleu de prune. Pruneo cæruleus.

f. Lavender blue. Lavendelblau. Bleu de lavande. Lavendula-cæruleus.

g. Smalt blue Schmalteblau. Bleu de fmalt. Smaltino-cæruleus.

h. Sky blue. Himmelblau. Bleu de ciel. Cælefti-cæruleus.

E. *Green.* Grün. Verd. Viridis.

a. Verdigris green. Spangrün. Verd de gris. Ærugineo-viridis.

b. Celadon green. Seladongrün. Verd celadon, ou de mer. Celadono-cæruleus.

c. Mountain green. Berggrün. Verd de montagne. Montano viridis.

d. Leek green. Lauchgrün. Verd de poireau ou de prafe. Prafino-viridis.

e. Emerald green. Schmaragdgrün. Verd emeraude. Smaragdino viridis.

f. Apple green. Apfelgrün. Verd de pomme. Pomaceo-viridis.

g. Graſs green. Grasgrün. Verd de pre. Gramineo-viridis.

h. Blackiſh green. Schwärtzlichgrün. Verd noiratre. Nigreſcenti viridis.

i. Piſtachio green. Piſtaziengrün. Verd de piſtache. Piſtacio viridis.

k. Aſparagus green. Spargelgrün. Verd d'aſperge. Aſparago viridis.

l. Olive green, Olivengrün. Verd d'olive. Olivaceo viridis.

m. Oil green. Oelgrün, Verd d'huile. Oleario-viridis.

n. Siſkin green. Zeiſiggrün. Verd ſerin. Acanthino viridis.

F. *Yellow.* Gelb. Jaune. Flavus.

a. Sulphur yellow Schwefelgelb. Jaune de ſoufre. Sulphureo flavus.

b. Braſs yellow, Meſſinggelb. Jaune de laiton. Orichalceo flavus.

c. Straw yellow. Strohgelb. Jaune de paille. Stramineo-flavus.

d. Bronze yellow. Speiſſgelb. Jaune de bronze. Æneo-flavus.

e. Wax yellow. Wachſgelb. Jaune de cire. Cereo-flavus.

f. Honey yellow. Honiggelb. Jaune de miel. Melleo-flavus.

g. Lemon yellow. Citrongelb. Jaune de citron. Citrino-flavus.

h. Gold yellow. Goldgelb. Jaune d'or. Aureo-flavus.

i. Ochre yellow. Ockergelb. Jaune d'ochre. Ochraceo-flavus.

k. Wine yellow. Weingelb. Jaune de vin. Vineo-flavus.

l. Cream, or Iſabella yellow. Iſabelgelb. Jaune iſabelle. Iſabellino-flavus.

m. Orange yellow. Oraniengelb. Jaune d'orange. Aurantiò-flavus.

G. *Red.* Roth. Rouge. Ruber.

a. Aurora, or morning red. Morgenroth. Rouge d'aurore. Auroreo-ruber.

b. Hyacinth red. Hyazinthroth. Rouge d'hyacinthe ou ponceau. Hyacinthino ruber.

c. Tile red, Ziegelroth. Rouge de brique, Lateritio-ruber.

d. Scarlet red Scharlachroth. Rouge ecarlate. Scarlatino-ruber.

e. Blood red. Blutroth. Rouge de ſang. Sanguineo-ruber.

f. Copper red. Kupferroth. Rouge de cuivre. Cupreo-ruber.

g. Carmine red. Karminroth. Rouge de carmin. Carmineo-ruber.

h. Fleſh red. Fleiſchroth. Rouge de chair. Carneo-ruber.

i. Cochineal red. Koſchenillroth. Rouge de cochenille. Coccineo ruber.

k. Crimſon red. Kermesinroth. Rouge cramoiſi. Carmeſino-ruber.

l. Roſe red. Roſenroth. Rouge roſe. Roſeo-ruber.

m. Peach blossom red. Pfirsichbluthroth. Rouge de fleurs de pecher. Persicino-ruber.

n. Columbine red. Kolumbinroth. Rouge columbin. Columbino-ruber.

o. Cherry red. Kirschroth. Rouge cerise. Ceracino-ruber.

p. Brownish red. Bräunlichroth. Rouge brunatre. Brunescenti-ruber.

H. *Brown.* Braun. Brun. Brunus.

a. Reddish brown. Röthlichbraun. Brun rougeatre. Rubescenti-brunus.

b. Clove brown. Nelkenbraun. Brun de gerofles. Caryophyllino-brunus.

c. Hair brown. Haarbraun. Brun de cheveux. Capillari-brunus.

d. Brocoli brown. Kohlbraun. Brun de chou. Brassicino-brunus.

e. Chesnut brown. Kastanienbraun. Brun de chataigne. Castaneo-brunus.

f. Yellowish brown. Gelblichbraun. Brun jaunatre. Flavescenti-brunus.

g. Pinchbeck brown. Tombackbraun. Brun de tombac. Tombacino brunus.

h. Wood brown. Holzbraun. Brun de bois. Ligneo-brunus.

i. Liver brown. Leberbraun. Brun de foie. Hepatico-brunus.

k. Blackish brown. Schwärzlichbraun. Brun noiratre. Nigrescenti-brunus.

2. *The intensity of the colours.* Die höhe der farben. L'intensité des couleurs. Vis colorum.

A. *Dark.* Dunkel. Foncée. Obscurus.

B. *Deep.* Hoch. Relevée. Eminens.

C. *Light.* Lichte. Claire. Clarus.

D. *Pale.* Blass. Pâle. Pallidus.

3. *The tarnished colours.* Angelaufenen farben. Couleurs superficielles. Colores superficiales. *are distinguished*

A. *According to their origin.* Entstehung. Origine. Origo.

a. In the bosom of the earth. Sogleich auf der lagerstätte.

b. On the exposition of the recent fracture to the action of the air. Bei oder auf jedesmaligen frischen bruche.

B. *According to the kind.* Nach der art der farben. D'apres leur variations. Quoad aspectum.

a. Merely simple. Einfache. Simples. Simplices.

α. Grey. Grau.

β. Black. Schwarz.

γ. Brown. Braun.

δ. Reddish, Röthlich.

b. Many party coloured together, (variegated). Mehrere zugleich. Bigarées. Variegati.

α. *Peacock tail, or pavonine.* Pfauenſchweifig. Queue de pavon. Pavonacis.

β. *Rainbow, or irideſcent.* Regenbogenfarbig. Iris. Iridei.

γ. *Pigeon neck, or columbine.* Taubenhälſig. Gorge de pigeon. Columbinii.

δ. *Tempered ſteel coloured.* Gehärtete ſtahlfarben. Acier trempé. Chalibei.

4. *The play of the colours.* Farbenſpiel. Jeu de couleurs. Luſus colorum.

5. *The changeability of the colours.* Die Farbenwandlung. La mutabilité des couleurs. Variatio colorum.

A. *On the ſurface, (obſerved by looking in different directions* on *the mineral,)* Auf der oberfläche beim daraufsehen. A la ſurface. In ſuperficie.

B. *Internally, (by looking* through it). Inwendig beim durchſehen. A l'interieur. Intus.

6. *The Irideſcence.* Das iriſiren. *Obſerved by*

A. *Looking* on *the mineral.*

B. *Looking* through *it.*

7. *The Opaleſcence.* Das opaliſiren.

A. *Common opaleſcence.* Das gemeine opaliſiren.

B. *Stellular opaleſcenee.* Das ſternförmige opaliſiren.

8. *The permanent alteration of the colours.* Die Farbenveränderung. Alteration des couleurs. Mutatio colorum.

9. *The delineations, or patterns, formed by the colours.* Die Farbenzeichnung, Deſſein de couleurs. Pictura colorum.

A. *Dotted.* Punctirt. Pointillé. Punctati.

B. *Spotted.* Gefleckt. Tacheté. Maculati.

C. *Clouded.* Gewolkt. Nuagé Nubiformis.

D. *Flamed.* Geflammt. Flambe. Flammei.

E. *Striped.* Geſtreift. Rubanné. Faſciati.

a. *Straight,* Gerade. Zonis rectis.

b. *Ringſhaped,* Ringförmig. Annulaire. Zonis concentricis notati.

F. *Veined.* Geadert. Veiné. Venati.

G. *Dendritic.* Baumförmig. Dendritique. Dendritici.

H. *Ruiniform.* Ruinenförmig. Ruiniforme. Ruinæ-formes.

II. The cohesion of the particles. Die Zuſammenhang der theile. Coheſion. Cohærentia partium.

1. *Solid, in general.* Feſte im allgemeinen.

A. *Solid in a ſtricter ſenſe.*

B. *Friable.* Zerreibliche.

2. *Fluid.*

The remaining Generic Characters will be placed at the concluſion of this Tabular View, that is, immediately after the particular Generic Characters.

PARTICULAR GENERIC EXTERNAL CHARACTERS.

Ist.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF SOLID MINERALS.

I. THE EXTERNAL ASPECT. Das äuſſere anſehen. Aſpect externe. Aſpectus externus.

I. *The external ſhape.* Die aüſſere geſtalt. Figure ou forme externe. Figura externa.

1. *Common external ſhape.* Gemeine auſſere geſtalten. Figure commune. Figura externa vulgaris.
   - A. *Maſſive.* Derb. Maſſive. Compactum?
   - B. *Diſſeminated.* Eingeſprengt. Diſſeminé. Inſperſum.
     - a. *Coarſely.* Grob eingeſprengt. En groſſes parties. Craſſe inſperſum.
     - b. *Minutely.* Klein eingeſprengt. En petites parties. Minuſcule inſperſum.
     - c. *Finely.* Fein eingeſprengt. En fines parties. Minute inſperſum.
   - C. *In angular pieces.* In eckigen ſtücken. En morceaux anguleux, ou en cailloux. In fruſtis anguloſis.
     - a. *Sharp cornered.* In friſcheckigen ſtücken. A bords tranchans. Angulis integris.
     - b. *Blunt cornered.* In ſtumpfeckigen ſtücken. A bords emouſſés. Angulis obſeletis.
   - D. *In grains.* Körnern, *divided.*
     - a. *With regard to ſize.* Gröſſe, *into*
       - α. *Large.* Graupich. Tres gros. Grandiniformibus.
       - β. *Coarſe.* In groben körnern. Gros. Grandibus.
       - γ. *Small.* In kleinen körnern. Petits. Grandiuſculis.
       - δ. *Fine.* In feinen Körnern. Fins. Minutis.

b. With regard to the exacter determination of the shape,

α. In angular grains. In eckigen körnern. Anguleux. Angulosis.

β. In flattish grains. In platten körnern. Applatis. Compressis.

γ. In roundish grains. In rundlichen körnern. Arrondis. Rotundis.

E. *In plates.* In platten. En lames. In laminis.

a. In thick plates. In dicken platten. Epaisses. Crassis.

b. In thin plates. In dünnen platten. Minces. Tenuibus.

F. *In membranes or flakes.* Angeflogen. En Couche superficielle. Superficiale.

a. Thick. Dick angeflogen. Epaisse. In membranis crassiusculis.

b. Thin. Dünn angeflogen. Mince. In membranis tenuibus.

c. Very thin. Zartangeflogen. Tres mince. In membranis tenuissimis.

2. *Particular external shape.* Besondere aussere gestalten. Formes exterieures imitatives. Figuræ externæ singulares.

A. *Longish.* Längliche. Alongées. Longiusculæ.

a. Dentiform. Zähnig. Dentiforme. Dentiformis.

b. Filiform. Drathförmig. Filiforme. Filiformis.

c. Capillary. Haarförmig. Capillaire. Capillaris.

d. Reticulated. Gestrickt. Tricoté ou en reseau. Retiformis.

e. Dendritic. Baumförmig. Dendritiforme. Dendritica.

f. Coralliform or coralloidal. Zackig. Coralliforme. Coralliformis.

g. Stalactitic. Tropfsteinartig. Stalactiforme. Stalactitica.

h. Cylindrical. Röhrenförmig. Cylindrique. Tubulosa.

i. Tubiform. Pfeifenröhrig. Tubiforme. Fistulosa.

k. Claviform. Kolbenförmig. Claviforme. Claviformis.

l. Fruticose. Staudenformig. En buissons. Fruticosa.

B. *Roundish.* Runde. Rondes. Rotundæ.

a. Globular. Kuglich. Globuleuse. Globulosa.

α. Sphœrical. Sphœrish. Spherique. Sphœrica.

β. Ovoidal. Elliptisch. Ovoide ou elliptique. Elliptica.

γ. Spheroidal. Spheroidisch. Spherique applati ou spheroidal. Sphœroidea.

δ. Amygdaloidal. Mandelförmig. Amygdaliforme. Amygdaloidea.

b. Botryoidal. Traubich. Uviformes. Uvæformis.

c. Reniform. Nierförmig. Reniforme. Reniformis.

d. Tuberose. Knollig. Bulbeux ou tuberculeux. Tuberosa.

e. Fused-like. Geflossen. Coulèe. Liquata *or* fusa.

C. *Flat.* Platte. Plattes. Planæ.

a. Specular. Spieglich. Speculaire ou miroiteé. Specularis.

b. In leaves. In blättchen. En feuilles *ou* en bractées. Bracteata.

D. *Cavernous.* Vertiefte. Creufes. Excavata.

a. Cellular. Zellich. Cellulaire. Cellulofa.

α. Straight or angulo cellular. Geradzellig.

1. *Hexagonal.* Sechfseitig.

2. *Polygonal.* Vielfeitig.

β. Circular cellular, or circulo-cellular. Rundzellich.

1. *Parallel.* Gleichlaufend.

2. *Spongiform.* Schwammförmig.

3. *Indeterminate.* Unbeftimmt.

4. *Double.* Doppelt.

b. With impreſſions. Mit eindrücken. Avec des impreintes. Impreffa.

α. Cubical. Würflichen. Cubiques. Veftigiis cubicis.

β. Pyramidal. Piramidalen. Pyramidales. Pyramidalibus.

γ. Conical. Kegelförmigen. Coniques. Conicis.

δ. Tabular. Tafelartigen. Tabuliforme. Tabulæformibus.

ε. Globular. Kuglichen. Spheriques. Globofis.

c. Perforated. Durchlöchert. Criblé. Perforata.

d. Corroded. Zerfreffen. Carié. Corrofa.

e. Amorphous. Ungeftaltet. Informe. Monftruofa.

f. Veſicular. Blafig. Bulleufe. Bellulofa.

E. *Entangled.* Verworren. Emmelées. Implicata.

a. Ramoſe. Aftig. Rameufe. Ramofa.

3. *Regular external ſhape, or cryſtallization.* Regelmäffige auffere Geftalten. Formes exterieures regulieres ou cryftallifations. Figuræ externæ regulares feu cryftallifationes.

A. *The genuineneſs.* Die wefentlichkeit. Effentialité. Effentialitas, *according to which cryſtals are either*

a. True. Wefentliche. Vrais cryftaux. Vera cryftallifatio, *or*

b. Suppoſititious. Aftercryftalle. Pfeudo-cryftaux. Pfeudo-cryftalle.

B. *The ſhape.* Die Geftalt. Forme des criftaux. Figura cryftallorum.

a. Which is made up of

α. Planes. Flächen. Faces. Plana.

β. Edges, Kanten. Bords. Margines.

γ Angles. Ecken. Angles. Apices, *and*

b. In which is to be obſerved,

α. The fundamental figure. Die grundgeftalt. Forme principale ou dominante. Figura fundamentalis.

i. *The parts of which are*

1, *Planes, either*

A. *Lateral.* Seitenflächen. Faces laterales. Plana lateralia, *or*

B. *Terminal.* Endflächen. Faces terminales. Plana terminalia.

2. *Edges.* Kanten, *either*

A. *Lateral.* Seitenkanten. Bords lateraux. Margines laterales, *or*

B. *Terminal.* Endkanten. Bords terminaux. Margines terminales, *and*

3. *Angles.* Ecken.

ii. *The kind of fundamental figure, which are*

1. *The icosahedron.* Icosaeder. Icosaedre. Icosaedrum.

2. *The dodecahedron.* Dodecaeder. Dodecaedre. Dodecaedrum.

3. *The hexahedron.* Hexaeder. Exaedre. Hexaedrum.

4. *The prism.* Säule. Prisme. Prisma.

5. *The pyramid.* Pyramide. Pyramide. Pyramis.

6. *The table.* Tafel. Table. Tabula.

7. *The lens.* Linse. Lentille. Lens.

iii. *The varieties of each kind of fundamental figure in particular, according to*

1. *Simplicity.* Einfacheit. Simplicité. Simplicitas, *which distinction is, however, confined to the pyramid, as occurring either*

A. *Single.* Einfach. Simple. Simplex, *which is either*

a. *Erect.* Rechts. Droite. Erecta.

b. *Inverted.* Verkehrt. Renversée. Inversa, *or*

B. *Double.* Doppelt. Double. Duplex, *and then*

a. *The lateral planes of the one pyramid set on the lateral planes of the other, either*

α. *Streight.* Gerade. Droite, *or*

β. *Oblique.* Schief. Biais, *or*

b. *On the lateral edges of the other.*

2. *Numbers of the planes; here we have to observe*

A. *The species of the planes.* Art der flächen. Espece des faces, *as*

a. *In the prism and pyramid the lateral planes are different, and*

b. *In the tables the terminal planes.*

B. *The number of them, according to which they may be, either*

a. *Tribedral or three ſided.* Dreiſeitig. Trilatere.

b. *Tetrahedral, or four ſided.* Vierſeitig. Quadrilatere.

c. *Hexahedral, or ſix ſided.* Sechſeitig. Sextilatere.

d. *Octahedral, or eight ſided.* Achtſeitig. Octolatere.

3. *Proportional ſize of the planes to one another.* Verhältniſs der flächen in anſehung der gröſſe zu einander. Grandeur des faces relativement les unes aux autres. Proportio planorum reſpectu magnitudinis.

A. *Equilateral.* Gleichſeitig. Faces egales. Plana æqualia.

B. *With unequal planes.* Ungleichſeitig. Faces inegales. Plana inequalia, *either*

a. *Indeterminately unequal.* Unbeſtimmt. Irregulierement inegales, *or*

b. *Determinately.* Beſtimmt. Regulierement inegales, *which are*

α. *Alternately broad and narrow.* Abwechſelend breitere und ſchmälere. Alternativement larges et etroites.

β. *Two oppoſite planes broader.* Zwei gegenüberſtehende breitere ſeitenflächen. Deux faces larges oppoſées.

γ. *Two oppoſite planes narrower.* Zwei Gegenuberſtehende ſchmälere ſeitenflächen. Deux faces etroites oppoſées.

4. *The angles under which the planes meet.* Winkeln, unter welchen die flächen zuſammenſtoſſen. Angles des faces entre elles. Quantitas angulorum, *theſe are either*

A. *The lateral edges.* Seitenkantenwinkel. Bords lateraux. Anguli Marginales laterales, *which are*

a. *Equiangular.* Gleichwinklich. Equiangles. Aequales.

b. *Rectangular.* Rechtwinklich. Rectangles. Recti.

c. Obliquangular. Schiefwinklich. Obliquangules. Obliqui.

d. Unequiangular. Verſchiedenwinklich. Inegaux. Diverſi, *or*

B. *The terminal edges.* Endkantenwinkel. Bords terminaux. Anguli Marginales terminales, *which are*

a. Rectangular. Recht. Rectangules. Recti, *or*

b. Obliquangular. Schief, *and this*

α. Parallel oblique. Gleichlaufend ſchief.

β. Alternate oblique. Abwechſelnd ſchief.

C. *The ſummit angle.* Endſpitzenwinkel. Angle ſolide du ſommet ou pointe. Anguli apicis, *which may be*

a. Very obtuſe. Sehr flach. Tres obtus.

b. Obtuſe. Flach. Obtus.

c. Rather obtuſe. Ein wenig flach. Un peu obtus.

d. Rectangular. Rechtwinklich. Rectangulaire.

e. Rather acute. Ein wenig ſpitzig. Un peu pointu.

f. Acute. Spitzig. Pointu, *or*

g. Very acute. Sehr ſpitzig. Tres pointu.

5. *The direction of the planes.* Richtung der flächen. Forme des faces. Directio planorum, *which is*

A. *Rectilinear or ſtraight.* Geradflächig. Plane. Rectiplana, *or*

B. *Curvilinear.* Krummflächig. Courbé. Curviplana. *Theſe differ partly by*

a. The poſition of the curvature. Nach der lage der krummung. Poſitio de la courbure. Situs, *being*

α. Concave. Einwärts gekrümmt. Concave. Concava.

β. Convex. Aufwärts gekrümmt. Convexe. Convexa.

γ. Concavo-convex. Ein und aufwärts gekrümmt, *and partly by*

b. The ſhape. Nach der geſtalt. Eſpece de courbure. Figura, *which is either*

α. Spherical. Sphäriſch.

β. Cylindrical. Cylindriſch.

1. *The convexity parallel with the ſides.* Die convexität mit den ſeitenflächen gleichlaufend, *or*

2. *The convexity parallel with the diagonal.* Die convexität mit den diagonale gleichlaufend.

γ. *Conical.* Coniſch. Conique. Conica.

6. *Plenitude of the cryſtals.* Völle des cryſtalls. Plenitude des criſtaux. Plenitudo cryſtallorum, *either*

A. *Full.* Voll. Plein. Plenæ.

B. *Excavated at the extremities.* Aufgehölt an den enden. Creuſe a l'extremitē. Terminis excavatæ.

C. *Hollow.* Hohl. Vuide. Cavæ.

B. *The alterations of the fundamental figure take place by*

I. *The truncation.* Abſtumpfung. Troncature. Truncatura. *Here we have to conſider*

1. *The parts of the truncation.* Die theile der abſtumpfung. Parties de la truncature. Partes troncaturæ. *Theſe are*

A. *The planes of the truncation.* Abſtumpfungsflächen. Faces de la troncature. Plana truncaturæ.

B. *The edges of the truncation.* Abſtumpfungskanten. Bords de la troncature. Margines truncati.

C. *The angles of the truncation.* Abſtumpfungsecken. Angles de la tronc. Apices truncaturæ.

2. *The determination of the truncation.* Die beſtimmung der abſtumpfung. Determination de la troncature. Determinatio truncaturæ, *which relates to*

A. *The placing of the truncation, or its ſituation.* Ort. Place de la troncature. Locus.

a. *On the edges.* An den kanten. Aux bords. Marginibus.

b. *On the angles.* An den ecken. Aux coins. Apicibus.

B. *Magnitude of the truncation.* Stärke oder gröſſe. Grandeur de la troncation. Magnitudo.

a. *Deep.* Stark. Forte. Multum truncatum.

b. *Slight.* Schwach. Legere. Parum truncatum.

C. *The ſetting on or application of the truncation.* Aufſetzung. Poſition relative de la troncature. Applicatio planorum.

a. *Straight.* Gerade. Droite. Recta applicata.

b. Oblique. Schief. De Biais. Oblique applicata.

D. *The direction of the truncating planes.* Die richtung der abstumpfungs flache. Forme de la troncature. Directio planorum, *which are*

a. Rectilinear. Geradflächig. Plane. Rectiplana.

b. Curvilinear or rounded off. Krummflächig. Courbe. Curviplana.

II. *The bevelment or cuneature.* Zuscharfung. Bisellement. Acumen. *Here we have to consider:*

1. *The parts of the bevelment.* Theile der zuschärfung. Parties du bisellement. Partes acuminis. *These are*

A. *The planes of the bevelment.* Die zuschärfungsflächen. Faces. Plana acuminis.

B. *The edges of the bevelment.* Die kanten der zuschärfung. Bords. Margines.

a. The proper edge. Die eigentliche zuschärfungskante. Bord formé par les deux faces du bisellement. Proprii acuminis; *and*

b. The edges formed by the bevelling and lateral planes. Die kanten zwischen den zuschärfungs-und seiten flächen. Bord formé par les faces du bisellement et les autres. Margines inter planem acuminis et lateralia.

C. *The angles of the bevelment.* Die zuschärfungsecken. Coins. Apices acuminis.

2. *The determination of the bevelment.* Bestimmung. Determination du bisellment. Determinatio acuminis. *Here we have to observe,*

A. *The situation.* Ort. Place du bisellement. Locus.

a. On the terminal planes. An den endflächen. Aux faces terminales. Planis terminalibus.

b. On the edges. An den kanten. Aux bords. Marginibus, *and*

c. On the angles. An den ecken. Aux coins. Apicibus.

B. *The magnitude.* Die stärke. Grandeur du bisellement. Magnitudo. *According to which it is either*

a. Deep. Stark. Fort. Multum, *or*

b. Slight. Schwach. Legere. Parvum.

C. *The angle.* Der winkel. Bord propre ou angle ſimple formé par les ſaces du biſellment. Angulus acuminis.

a. Obtuſe. Flach. Obtus. Obtuſus.

b. Rectangular. Rechtwinklich. Rectangulaire. Rectangulus.

c. Acute. Scharf. Aigu. Acutus.

D. *The uniformity.* Die fortdauer.

a. Uniform. Ungebrochen.

b. Broken. Gebrochen. Fractus.

α. Once broken. Einmal gebrochen.

β. Twice broken. Zweimal gebrochen.

E. *The application.* Die aufsetzung. Poſition relative du biſellement. Applicatio.

a. Of the bevelment itſelf. Die zuſchärfung ſelbſt. Poſition du biſellement. Acuminis ipſius. *which is either*

α. Straight. Gerade. Droit. Recta, *or*

β. Oblique. Schief. De biais. Obliqua.

b. Of the planes. Flächen. Celle des biſeaux. Planorum.

α. On the lateral planes. Auf die ſeitenflächen. Sur les faces laterales. Ad plana lateralia.

β. On the lateral edges. Sur les bords lateraux. Ad margines laterales.

III. *The acumination.* Zuſpitzung.

Here we have to conſider,

1. *The parts of the acumination.* Die theile der zuſpitzung. Parties du pointement. Partes mucronis, *which are*

A. *Acuminating planes.* Zuſpitzungsflächen. Faces. Plana.

B. *Edges of the acumination.* Zuſpitzungſkanten. Bords. Margines, *which are either*

a. Acuminating edges. Die eigentliche zuſpitzungſkanten. Bords du pointement meme.

b. Terminal edges of the acumination. Die endkanten der zuſpitzung. Bord terminal du pointement.

c. Edges formed by the acuminating and lateral edges. Die kanten, welche die zuſpitzungsflächen mit den ſeitenflächen machen. Bords que les faces du pointement font avec les autres.

C. *The acuminating angles.* Die zuſpitzungſecken. Coins du pointement. Apices.

3. *The determining the acumination depends on obſerving,*

A. *The ſituation of it.* Ort. Place du pointment. Locus. *either*

a. *On the angles.* An den ecken. Aux coins. Apicibus, *or*

b. *On the extremities.* An den enden. Aux faces terminales. Terminis.

B. *The acuminating planes.* Die zuſpitzungsflachen. Faces du pointement. Plana.

a. *Their number.* Deren anzahl. Leur nombre. Numerus.

b. *Their proportional magnitude between themſelves.* Deren verhaltniſſmäſſige gröſſe gegen einander. Grandeur relative entre elles. Magnitudo mutua.

c. *Their ſhape.* Deren geſtalt. Leur contour. Figura, *either*

α. *Determinate.* Beſtimmt. Regulier. Determinata, *or*

β. *Indeterminate.* Unbeſtimmt. Irreguliere. Indeterminata.

d. *Their ſetting on* Die aufsetzung. Poſition. Applicatio, *either*

α. *On the lateral planes.* Auf die ſeitenflächen. Sur les faces de la forme ſimple. Ad plana lateralia, *or*

β. *On the lateral edges.* Auf die ſeitenkanten. Sur les bords de la forme ſimple. Ad margines laterales.

C. *The ſummit angle.* Der winkel der zuſpitzung. Bord du pointement. Angulus, *which is*

a. *Obtuſe.* Flach. Obtus. Obtuſus.

b. *Rectangular.* Rechtwinklich. Rectangulaire. Rectus.

c. *Acute.* Scharfwinklich. Aigu. Acutus.

D. *The magnitude.* Die ſtärke. Grandeur du pointement. Magnitudo, *according to which cryſtals are*

a. *Deeply.* Stark. Fort. Multum mucronatum, *or*

b. *Slightly acuminated.* Schwach. Faible. Parum mucronatum.

E. *The termination.* Die endigung. Terminaiſon du pointement. Terminatio, *as the acumination may terminate.*

a. In a point. In einen punct. Un point. In punctum, *or*

b. In a line. En une line. Une ligne. In lineam.

IV. The divifion of the planes.

1. *The number, as into two, three, four, or fix compartments.*
2. *How the dividing edges run.*

V. *Multiplied alterations.* Mehrfachen veränderung der grundgeftalt, *which occur in certain cryftals, and which are, either*

1. *Coordinate.* Nebeneinandergefetzt, *or*
2. *Superimpofed.* Ubereinandergefetzt.

For the more exactly determining a cryftalization may be adjoined the general determination of its planes, ond then

α. The number of the planes in general, and of each fpecies in particular, and

β. The fhape of each fpecies of plane muft be given.

Befides thefe, in defcribing a cryftallization, the following may be obferved and adjoined;

a. The choice of different modes of defcribing one and the fame cryftallization.

The principal or moft effential form of a cryftallization will be, however, determined

α. by the larger planes.

β. by the greater regularity.

γ. by its moft frequent occurrence.

δ. by its affinity with the other fundamental forms of the fame foffil.

ε. by the fuitability and adaptation to the alterations which occur in the cryftal fuite or cryftallization, and

ζ. by the greater fimplicity.

b. The tranfitions which arife from thence

α. that the new or alterating planes become gradually larger, at the expence of certain previous planes, which are at length wholly obliterated,

β. by alterations taking place in the proportion of the planes between themfelves,

γ. by alteration of the angles

δ. by convexity, and

ε. by aggregation.

c. *Obstacles which prevent, or at least render the exact determination of certain crystals, difficult, are occasioned by*

α. *their obliquity.* Verschobenseyn. L'allongement. Obliquitas planorum et angulorum.

β. *their incorporation.* Verwachsenseyn. L'incorporation dans un fossil. Coalescentia.

γ. *their being broken.* Verbrochenseyn. Breches. Ruptura, *and*

δ. *their too great minuteness.* Die zu grosse kleinheit. La trop grand petitesse. Nimia parvitas.

C. *The attachment of the crystals.* Der zusammenhang der krystallen. Le grouppement ou l'adherence des crystaux entre eux. Aggregatio crystallorum, *according to which they may be either*

a. *Solitary.* Einzeln. Separés. Solitariæ, *and this again*

α. *Loose.* Lose. Isolé ou solitaire. Solutæ.

β. *Imbedded.* Eingewachsen. Implanté. Innatæ, *or*

γ. *Superimposed.* Aufgewachsen. Superposé. Adnatæ.

b. *Aggregated.* Zusammengehäuft. Groupes aggregés. Connata, *either*

α. *A determinate number growing together in a determinate manner,*

1. *With respect to number,*

i. *Pair wise, (twin crystals.)* Zwillingscrystalle. Jumeaux. Gemellæ.

ii. *Three together, (triple crystals).* Drillings-crystalle. Jumeaux triples. Tergeminæ.

2. *With regard to the manner of their connection.* Zusammenfugung

i. *Intersecting one another.* Durcheinandergewachsen

ii. *Penetrating one another.* Ineinandergewachsen

iii. *Adhering to one another.* Aneinandergewachsen

β. *Many together, but merely simply aggregated.* Einfach zusammengehäuft, *either*

i. *On one another.* Aufeinander. Les uns sur les autres. Superimpositæ.

ii. *Side by side.* Aneinander. Les uns a cotés des autres. Ad-positæ, *or*

iii. *Promiscuously.* Durcheinander gewachsen. Sans ordre. Decussatæ.

γ. *Many together, doubly aggregated.* Mehrere doppelt zusamengehaüft. Plusieurs crystaux doublement aggregés. Plures dupliciter connatæ, *the most remarkable are,*

In longish particularly prismatic crystals.
- i. *Fascicular or scopiform.* Buchelförmig. En faisceau. Fasciculatim.
- ii. *Manipular or sheaf-like.* Garbenförmig.
- iii. *Columnar.* Stangenförmig. En barres.
- iv. *Pyramidal.* Pyramidal. En pyramides. Pyramidaliter.

In tabular crystals.
- v. *Rose-like.* Rosenförmig. En rose. Rosieformiter.
- vi. *Amygdaloidal.* Mandelförmig. En amandes. Amygdalorum instar.

In pyramidal crystals.
- vii. *Bud like.* Knospenförmig. En boutons. Gemmæformiter.

In roundish or tessular crystals.
- viii. *Globular.* Kuglich ou kugelförmig. En boule. Globose.
- ix. *In rows.* Reihenförmig. En rayes. Ordinatim.

D. *The magnitude of the crystals.* Die grösse der krystallen.

a. *With regard to their magnitude in general, crystals are divided into,*

α. *Uncommonly large.* Ungewöhnlich grofs. Extremement grand. Eximie grandes.

β. *Very large.* Sehr grofs. Tres grand. Pergrandes.

γ. *Large.* Grofs. Grand. Grandes.

δ. *Middle sized.* Von mittlerer grösse. Moyenne grandeur. Mediocriter grandes.

ε. *Small.* Klein. Petit. Parvæ.

ζ. *Very small.* Sehr klein. Tres petit. Minutæ.

η. *Microscopic.* Ganz klein. Tout petit. Minutissimæ.

b. *According to the relative greatness of one dimension in comparison with the other, crystals are distinguished into*

α. *Short and low, or long and high.* Kurz und niedrig und lang und hoch. Court et abaisse et long. Humiles et longæ.

β. *Broad and longish.* Breit & langlicht. Large et allongé. Latæ et arctæ.

γ. *Thick and slender.* Dick und schwach. Epais et mince. Crassæ et graciles.

δ. *Acicular and capillary.* Nadelförmig und haarförmig. En aiguille et capillaire. Acuformes et capillares.
ε. *Ensiform.* Spieffig. En lance. Subulatæ.
ζ. *Globular or tessular.* Kuglich oder teffularifch. En alene. Globofæ et teffulares.

Extraneous external shape. (petrifactions.) Fremdartfige äuffere geftalten. Verfteinerungen.

A. *From the animal kingdom.*
a. *Of quadrupeds.* Saugethieren.
b. *Of birds.* Vögeln.
c. *Of amphibious animals.* Amphibien.
d. *Of fishes.* Fifchen.
e. *Of insects.* Infecten.
f. *Of shells.* Schaalthieren, *as*
* *Univalves.*
i. *Belemnites.*
ii. *Ammonites.*
iii. *Turbenites.*
iv. *Strombites, &c.*
* *Bivalves.*
i. *Chamites.*
ii. *Terebratulites.*
iii. *Mytulites.*
iv. *Gryphites.*
v. *Ostracites, &c.*
* *Multivalves*
i. *Balanites, &c.*
g. *Of crustaceous animals, as echinites, asterites, &c.*
h. *Of corals, as* madreporites, reteporites. Encrenites. Entrochites, &c.

B. *From the vegetable kingdom,*
a. *Impressions of plants*
b. *Transmuted wood, or petrified wood.*

II. The external surface. Die auffere oberfläche. La furface exterieure. Superficies externa.
1. *Uneven.* Uneben. Inegale. Inæqualis.
2. *Granulated.* Gekörnt. Granelée. Granata.
3. *Rough.* Rauh. Apre. Afpera.
4. *Smooth.* Glatt. Liffe. Lævis.
5. *Streaked.* Geftreift. Striée. Striata

A. *Simply streaked.* Einfach geſtreift. Simplement ſtriee. Simpliciter ſtriata

a. *Longitudinally.* In die queere geſtreift. En travers. Latitudinaliter

b. *Tranſverſely.* In die lange geſtreift

c. *Diagonally.* Diagonaliter. Diagonalement. Diagonaliter

d. *Alternately.* Abwechſelnd geſtreift. Rayee. Alterne.

B. *Doubly ſtreaked.* Doppelt geſtreift. Doublement ſtriée. Dupliciter ſtriata

a. *Plumiformly.* Federartig. En barbes de plumes. Pennatim.

b. *Reticularly.* Geſtrickt geſtreift. En tricot. Reticulatim.

6. *Druſy.* Druſig. Druſique. Druſica.

II. The external lustre. Der auſſere glanz. L'eclat exterieur. Nitor externus.

1. *The intenſity of the luſtre.* Stärke des glanzes. Intenſité ou degrés de l'eclat. Gradus nitoris.

Here we have to determine the following degrees:

A. *Splendent.* Starkglänzend. Tres eclatant. Multum nitens.

B. *Shining.* Glänzend. Eclatant. Nitens.

C. *Gliſtening.* Wenigglänzend. Peu eclatant. Parum nitens.

D. *Glimmering.* Schimmernd. Brillant où trembltant. Micans.

E. *Dull.* Mat. Matt. Nitoris expers.

2. *The ſort of luſtre.* Art des glanzes. Eſpece d'eclat. Species nitoris

A. *Metallic luſtre.* Metalliſcher glanz. Eclat metallique. Nitor metallicus.

B. *Common luſtre.* Gemeiner glanz, *which is diſtinguiſhed into*

a. *Semimetallic.* Halbmetalliſcher glanz. Demimetallique. Semimetallicus

b. *Adamantine.* Demantglanz. Diamant. Adamantinus

c. *Pearly.* Perlmutterglanz. Nacre. Margaratinus

d. *Reſinous.* Fettglanz. Cire ou gras. Cereus

e. *Vitreous.* Glasglanz. Vitreux. Vitreus

2. The aspect of the fracture. Bruchanſehen. Aſpect de la caſſure. Aſpectus internus.

IV. *The luſtre of the fracture, as in the external luſtre.*

V. *The fracture.* Der bruch. La caſſure ou la ſurface interieur. Fractura, *of which are*

1. *The following varieties,*

A. *The compact fracture.* Dichte bruch. Denſe. Denſa. *This is*

a. *Splintery.* Splittrich. Ecailleuſe. Feſtucoſa α. *Coarſe ſplintery.* Grobſplittrich. A grandes ecailles. Feſtucis majuſculis.

β. *Fine ſplintery.* Kleinſplittrich. A petites ecailles. Feſtucis minuſculis

b. *Even.* Eben. Egale ou unie. Aequalis

c. *Conchoidal.* Muſchlich. Concoide. Conchæformis.

α. *With reſpect to ſize.* Nach der gröſſe. D'aprés la grandeur de concavités. Reſpectu magnitudinis

i. *Large conchoidal.* Groſſmuſchlich. Tres evaſé. Grandiuſcula.

ii. *Small conchoidal.* Kleinmuſchlich. Peu evaſé. Minuſcula

β. *With regard to perfection.* Nach der aufzeichnung. D'aprés la perfection de concavités. Reſpectu perfectionis.

i. *Perfect conchoidal.* Volkommen muſchlich. Parfait. Perfecta

ii. *Imperfect conchoidal.* Unvolkommen muſchlich. Imparfait. Imperfecta.

d. *Uneven.* Uneben. Anguleuſe ou inegale. Inæqualis.

α. *Coarſe grained.* Vom grobem korne. Grandes inegalites. Granograndi

β. *Small grained.* Von kleinem korne. Petites inegalités. Grano minuſculo.

γ. *Fine grained.* Von feinem korne. Fines inegalités. Grano minuto.

e. *Earthy.* Erdig. Terreuſe. Terrea.

f. *Hackly.* Hakig. Crochu. Hamata.

B. *The fibrous fracture.* Der faſriche bruch. Fibreuſe. Fibroſa. *Here we have to obſerve,*

a. *The thickneſs of the fibres.* Die ſtärke der faſern. Epaiſſeur des fibres. Craſſities fibrarum,

α. *Coarſe fibrous.* Grobfaſrig. Groſſes fibres. Fibris craſſiusculis.

β. *Delicate fibrous.* Zartfaſrig. Minces fibres. Fibris tenuibus.

b. *The direction of the fibres.* Die richtung der faſern, Forme des fibres. Directio fibrarum,

α. *Straight fibrous.* Geradfaſrig. Droites fibres. Fibris rectis.

β. *Curved fibrous.* Krummfaſrig. Courbes fibres. Fibris curvis *c. The pofition of the fibres.* Die lage der fafern. Pofition des fibres. Situs.

α. Parallel fibrous. Gleichlaufend fafrig. Fibres paralleles. Fibris parallelis

β. Diverging fibrous. Aufeinanderlaufend fafrig. Fibres divergentes. Fibris divergentibus

i. *Stellular.* Sternförmig. En etoiles. Stellatim

ii. *Fafcicular or fcopiform.* Bufchelförmig. En faifceaux. Fafciculatim

γ. Promifcuous. Unter oder durcheinanderlaufend fafrig. Fibres croifées. Fibris decuffatis.

C. *The radiated fracture.* Der ftrahliche bruch. Rayonnée. Radiata *Here we have to determine*

a. The breadth of the rays. Die breite der ftrahlen. Largeur des rayons. Latitudo radiorum

α. Uncommonly broad radiated. Aufferordentlich breitftrahlich. Tres larges. Radiis eximie latis

β. Broad radiated. Breitftrahlich. Larges. Radiis latis.

γ. Narrow radiated. Schmalftrahlich. Etroits. Radiis arctis.

b. The direction of the rays. Die richtung der ftrahlen. Forme des rayons. Directio

α. Straight radiated. Geradftrahlich. Droits. Radiis rectis.

β. Curved radiated. Krummftrahlich. Courbes. Radiis curvis.

c. The pofition of the rays. Die lage der ftrahlen. Pofition des rayons. Situs.

α. Parallel. Gleichlaufend. Paralleles. Radiis parallelis.

β. Diverging. Aufeinanderlaufend. Divergens. Radiis divergentibus

i. *Stellular.* Sternförmig. En etoiles. Stellatim

ii. *Fafcicular or fcopiform.* Bufchelförmig. En faifceaux. Fafciculatim.

γ. Promifcuous. Untereinanderlaufend. Croifés ou entrelacés. Radiis decuffatis.

d. The paffage of the rays, or cleavage. Der durchgang der ftrahlen. Direction des rayons.

e. The aspect of the rays surface. Das ansehen der strahlichen flächen. Aspect des faces rayonnées.

D. *The foliated fracture.* Der blättriche bruch. Feuilletée. Lamellosa.

a. The size of the folià. Die grösse der blätter. Grandeur des feuillets. Magnitudo lamellarum.

b. The degree of perfection of the foliated fracture. Die volkommenheit. Perfection de la cassure feuilletée. Perfectio.

α. Highly perfect, or speculer splendent. Höchst volkommen oder spiegelflächig blättrich. Tres parfaitement feuilletée. Perfectissime lamellosa.

β. Perfect foliated. Volkommen blättrich. Parfaitement feuilletée. Perfecte lamellosa.

γ. Imperfect foliated. Unvolikomen blättrich. Imparfaitement feuilletée. Imperfecte lamellosa.

δ. Slaty. Schiefrig. Schisteuse. Shistosa.

ε. Concealed foliated. Versteckt blättrich. Feuilletèe cachée, Confuse lamellosa.

c. The direction of the folia. Richtung. Forme des feuillets. Directio.

α. Plane foliated. Geradblättrich. Droits. Recta.

β. Curved foliated. Krummblättrich. Courbes. Curva.

i. *Spherical.* Sphærisch. Spherique. Sphaerica.

ii. *Undulating.* Wellenförmig. Ondulé. Undulatim.

iii. *Floriform.* Blumig-blättrich. Palmé. Floriformiter.

iv. *Indeterminate.* Unbestimmt. Indeterminé. Indeterminatæ.

d. The position of the folia. Die lage der blätter. Position des feuillets. Situs.

α. Common foliated. Gemeinblättrich.

β. Scaly foliated. Schuppigblættrich.

e. The aspect of the surface of the folià. Das ansehen der blattrichen fläche.

α. Smooth. Glatt.

β. Streaked. Gestreift.

f. The passage of the folia, or cleavage. Der durchgang der blætter. Clivage ou direction des feuillets. Meatus lamellarum appears to have worn a paſſage through the oppoſing rocks, and at length, as Profeſſor Playfair well expreſſes it, it has paſſed from the ſtate of a lake to that of a river. The river has gradually deepened its channel, and is diminiſhed in height and breadth. That the river formerly ſtood at a greater height, and poſſeſſed greater breadth than it does at preſent, is ſhewn by the great height of the original or high banks and their diſtance from one another.

The river is gradually diminiſhing.

SPRINGS.

The only ſprings deſerving of attention in this county are thoſe near the village of Moffat, which have been long well known on account of their medicinal virtues *.

* There is a chalybeate ſpring at Brow, in the pariſh of Ruthwell.

There are three ſprings, a ſulphureous, and two chalybeate.

The ſulphureous ſpring, or, as it is called, Moffat well, is about a mile and a half from the village of Moffat. It oozes out of a rock of compact grey wacke, which contains interſperſed iron pyrites. At a little diſtance there is a bog, which along with the pyrites in the grey wacke probably afford the ſulphureous impregnation to the ſpring. The water has a ſtrong ſulphureous ſmell, reſembling that of the ſulphureous waters of Harrowgate, but not quite ſo ſtrong. It has a ſlight ſaline taſte, and ſparkles when firſt taken from the ſpring, particularly when poured out of one glaſs into another. The ſides of the well are covered with a yellowiſh grey cruſt of ſulphur, and when the water has been allowed to ſtand ſome days without pumping, it becomes covered with a yellowiſh white film of ſulphur. According to the analyſis of the late Dr

Moffat well.

Qualities.

A. *In the direction of the lamellæ.* Richtung. Diverſite des formes des lames. Directio.

a. *Straight lamellar.* Geradſchaalig. Planes. Rectæ.

α. *Quite ſtraight.* Ganz gerad. Entierement planes. Perfectæ rectæ, *or*

β. *Fortificationswiſe bent.* Fortificationſartig gebogen ſchaalig. En zigzag. Inſtar munimentorum.

b. *Curved lamellar.* Krummſchaalig. Courbes. Curvae.

α. *Indeterminate curved lamellar.* Gemein krummſchalig. Indeterminées. Vulgariter.

β. *Reniform curved lamellar.* Nierförmig gebogen ſchaalig. En rognons. Reniformiter.

γ. *Concentrical curved lamellar.* Concentriſch ſchaalig. Concentriques. Concentrice.

1. *Spherical.* Sphæriſh. Spheriques. Sphaerico concentrice.

2. *Conical.* Coniſch. Coniques. Conico concentri

B. *In the thickneſs.* In der ſtärke. Epaiſſeur des lames. Craſſities.

a. *Very thick lamellar.* Sehr dickſchaalig. Tres epaiſſes. Craſſae.

b. *Thick lamellar.* Dickſhaalig. Epaiſſes. Craſſiusculae.

c. *Thin lamellar.* Dünnſchaalig. Minces. Tenues.

d. *Very thin lamellar.* Sehr dünn ſchaalig. Tres minces. Tenuiſſimae.

3. *Columnar diſtinct concretions.* Stänglich abgeſonderte ſtucke. Colonnaires. Scapiformes, *which are diſtinguiſhed*

A. *According to the direction.* Nach der richtung. Contournement des colonnes. Directio, *into*

a. *Straight columnar.* Geradſtänglich. Droites. Rectae.

b. *Curved lamellar.* Krummſtänglich. Courbés. Curvæ.

B. *With regard to thickneſs.* Stärke. Epaiſſeur des colonnes. Craſſities, *into*

a. *Very thick columnar.* Sehr dick. Tres epaiſſes et grandes. Columnares.

b. *Thick columnar.* Dickſtänglich. Epaiſſes. Craſſae.

c. *Thin columnar, or priſmatic.* Dünnſtänglich. Minces. Tenues.

d. *Very thin columnar or priſmatic.* Sehr dunnſtänglich. Tres minces. Tenuiſſimae.

C. *With reſpect to ſhape.* Geſtalt, *into*

a. *Perfect columnar.* Volkommen ſtänglich. Parfaites. Perfecte.

b. Imperfect columnar. Unvollkommen ſtänglich. Imparfaites. Imperfecte.

c. Cuneiform columnar. Keilförmig ſtänglich. Cuneiformes. Cuneatim.

D. *According to the poſition.* Lage, *into*

a. Parallel. Gleichlaufend.

b. Diverging. Aufeinanderlaufend.

c. Promiſcuous. Untereinanderlaufend.

4. *In ſeveral minerals, two of theſe varieties, or different ſizes of the ſame variety of diſtinct concretions, occur together, either*

A. *The one including the other, or*

B. *The one traverſing the other.*

VIII. *The ſurface of the diſtinct concretions.* Abſonderungsfläche. Surface des pieces ſeparees. Superficies partium ſegregatarum.

1. *Smooth.* Glatt. Liſes. Laevis.

2. *Rough.* Rauh. Rude ou apre. Aſpera.

3. *Streaked.* Geſtreift. Striée. Striata.

4. *Uneven.* Uneben. Raboteuſe. Inaequalis.

IX. *The luſtre of the diſtinct concretions,* Abſonderungſglanz, *is determined in the ſame manner as the external luſtre.*

IV. GENERAL ASPECT. Allgemeines anſehen.

X. *The tranſparency.* Durchſichtigkeit. Tranſparence. Pelluciditas. *The degrees are*

1. *Tranſparent.* Durchſichtig. Diaphane. Diaphanum, *either*

A. *Simply tranſparent.* Gemein durchſichtig. Diaphane ſimple. Vulgare.

B. *Duplicating tranſparent.* Verdoppelnd durchſichtig. Diaphane double. Duplicans.

2. *Semitranſparent.* Halbdurchſichtig. Semidiaphane. Semidiaphanum.

3. *Tranſlucent.* Durchſcheinend. Tranſparent. Tranſparens?

4. *Tranſlucent at the edges.* An den kanten durchſcheinend. Tr parent aux bords. Marginibus tranſparens

5. *Opaque.* Undurchſichtig. Opaque. Opacum.

XI. *The ſtreak.* Der ſtrich. Raclure. Raſura. *the colour of which is either*

1. *Similar.* Gleich. Concolor. Ejuſdem coloris, *or*

2. *Different.* Verſchieden. Diſcolor. Diverſi coloris *from the mineral.*

XII. *The ſoiling or colouring.* Abfarben. Tachure. Tinctura, *by by which minerals*

1. *Soil.* Abfärben, *either*

A. *Strongly.* Stark, *or*

B. *Slightly.* Etwas, *or*

2. *Do not ſoil.* Nichtabfârben.

IV. CHARACTERS FOR THE TOUCH.

XIII. *The hardneſs.* Die härte. Dureté. Durities. *The degrees are*

1. *Hard.* Hart. Dur. Durum.
   A. *Reſiſting the file.* Wird von der feile gar nicht angegriffen. Reſiſtant a la lime. Limae non cedens.
   B. *Yielding a little to the file.* Wird wenig angegriffen. Cedant un peu a la lime. Limae parum cedens.
   C. *Yielding to the file.* Wird von der feile ſtark angegriffen. Cedant a la lime. Limae cedens.
2. *Semihard.* Halbhart. Demidure. Semidurum.
3. *Soft.* Weich. Tendre. Molle.
4. *Very ſoft.* Sehr weich. Tres tendre. Molliſſimum.

XIV. *The tenacity.* Feſtigkeit. La ductilité. Ductilitas. *The degrees of which are*

1. *Brittle.* Spröde. Aigre. Fragile.
2. *Sectile or mild.* Milde. Traitable. Lene.
3. *Ductile.* Geſchmeidig. Malleable. Ductile.

XV. *The frangibility.* Der zuſammenhalt. La tenacité. Tenacitas.

1. *Very difficultly frangible.* Sehr ſchwer zerſpringbar. Tres Tenace. Tenaciſſimum.
2. *Difficultly frangible.* Schwer zerſpringbar. Tenace. Tenax.
3. *Not particularly difficultly frangible, or rather eaſily frangible.* Nicht ſonderlich ſchwer zerſpringbar. Peu tenace. Non multum tenax.
4. *Eaſily frangible.* Leicht zerſpringbar. Caſſant facilement. Parum tenax.
5. *Very eaſily frangible.* Sehr leicht zerſpringbar. Caſſant tres facilement. Valde parum tenax.

XVI. *The flexibility.* Die biegſamkeit. Flexibilité. Flexibilitas, *according to which minerals are either*

1. *Flexible.* Biegſam. Flexible. Flexibile, *and this either*
   A. *Elastic flexible.* Elaſtiſch biegſam. Elaſtique. Elaſtice, *or*
   B. *Common flexible.* Gemein biegſam. Ordinaire. Vulgariter, *or*
2. *Inflexible.* Unbiegſam. Inflexible. Inflexibile.

XVII. *The adheſion to the tongue.* Das anhängen an der zunge. Le happement a la langue. Adhaeſio ad linguam, *the degrees of which are,*

1. *Strongly adheſive.* Stark an der zunge hängend. Happe beaucoup. Fortiter adhaeret.

2. *Pretty ſtrongly.* Ziemlich ſtark. Aſſès. Mediocriter.
3. *Weakly, or ſomewhat.* Etwas. Un peu. Aliquantum.
4. *Very weakly, or a little.* Wenig. Tres peu. Parum.
5. *Not at all.* Gar nicht. Pas du tout. Nihil.

VII. CHARACTERS FOR THE HEARING. Kenzeichen für das gehör.

XVIII. *The ſound.* Der ton. Son. Sonus. *The different ſorts of which occurring in the mineral kingdom, are*

1. *A ringing ſound.* Klingen. Tintement. Clangor.
2. *A grating ſound.* Rauſchen. Bruyement. Strepitus. *And*
3. *A creaking ſound.* Knirſchen. Criſſement. Stridor.

IId.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF FRIABLE MINERALS. BESONDERE GENERISCHE KENNZEICHEN DER ZERREIBLICHEN FOSSILIEN.

I. *The external ſhape.* Auſſere geſtalt. Figure exterieure. Figura externa. *This is*

1. *Maſſive.* Derb. Maſſive. Compactum.
2. *Diſſeminated.* Eingeſprengt. Diſſeminé. Inſperſum.
3. *Thinly coating.* Als dünner überzug. En croute mince. Superinductum.
4. *Spumous.* Schaumartig. En ecume. Spumaeforme, *and*
5. *Dendritic.* Baumförmig. Dendritique. Dendriticum.

II. *The luſtre.* Glanz. Eclat. Nitor.

1. *The intenſity.* Stärke des glanzes. Intenſité de l'eclat. Gradus nitoris.
   - A. *Glimmering.* Schimmernd. Tremblotant. Micans.
   - B. *Dull.* Matt. Mat. Nitoris expers.
2. *The ſort.* Art des glanzes. Natur de l'eclat. Species nitoris.
   - A. *Common glimmering.* Gemein ſchimmernd. Ordinaire. Vulgaris.
   - B. *Metallic glimmering.* Metalliſchſchimmernd. Metallique. Metallicus.

III. *The aſpect of the particles.* Anſehen der theilchen. L'aſpect des parties. Aſpectus particularum.

1. *Duſty.* Staubige. Pulverulentes. Pulveriformes.
2. *Scaly.* Schuppige. Ecailleuſes. Squamm ſœ.

IV. *The ſoiling or colouring.* Abfärben. La tachure. Tinctura.

1. *Strongly.* Stark. Beaucoup. Multum tingons.
2. *Slightly.* Wenig. Peu. Parum.

V. *The friability.* Zerreiblichkeit. Friabilité. Friabilitas.

1. *Looſe.* Loſe. Incoherant. Non conglutinatæ.
2. *Cohering.* Zuſammengebacken. Coherant. Conglutinatæ.

IIId.

PARTICULAR GENERIC EXTERNAL CHARACTERS OF FLUID MINERALS. Besondere generische kennzeichen der fluissgen fossilien.

I. *The lustre.* Glanz. Eclat. Nitor.
  1. *Metallic.* Metallischer. Metallique. Metallicus.
  2. *Common.* Gemeiner. Ordinaire. Vulgaris.

II. *The transparency.* Durchsichtigkeit. Transparence. Pelluciditas.
  1. *Transparent.* Durchsichtig. Diaphane. Diaphanum.
  2. *Troubled, or turbid.* Trübe. Troublé. Turbidum.
  3. *Opaque.* Undurchsichtig. Opacum.

III. *The fluidity.* Flüssigkeit. Fluidité. Fluiditas.
  1. *Fluid.* Flüssig. Parfaite. Fluidum.
  2. *Viscid.* Zahe. Visqueuse. Lentum.

REMAINING GENERIC EXTERNAL CHARACTERS. Uebrige allgemeine generische aussere kennzeichen.

IV. *The unctuosity.* Fettigkeit. Toucher ou gras. Pinguitudo. *Of this we have the following degrees.*
  1. *Meagre.* Mager. Maigre. Macrum.
  2. *Rather greasy.* Ein wenig fett. Un peu gras. Parum pingue.
  3. *Greasy.* Fett. Gras. Pingue.
  4. *Very greasy.* Sehr fett. Fort gras. Pinguissimum.

V. *The coldness,* Kälte. Froid. Frigus; *with respect to which minerals are*
  1. *Cold.* Kalt. Froid. Frigidum.
  2. *Pretty cold.* Ziemlich kalt. Mediocrement froid. Frigidiusculum.
  3. *Rather cold.* Wenig kalt. Mediocrement froid. Parum frigidum.

VI. *The weight.* Schwere. La pesanteur specifique. Gravitas.
  1. *Swimming or supernatant.* Schwimmend. Surnageant. Natans.

2. *Light.* Leichte. Leger. Leve.

3. *Not particularly heavy, or rather light.* Nicht ſonderlich ſchwer. Mediocrement peſant. Parum graves.

4. *Heavy.* Schwer. Peſant. Graves.

5. *Uncommonly heavy.* Auſſerordentlich ſchwer. Tres peſant. Eximie grave.

VII. *The ſmell.* Geruch. Odeur. Odor.

1. *Spontaneouſly emitted.* Für ſich.

A. *Bituminous.* Bituminös. Bitumineuſe. Bituminoſus.

B. *Faintly ſulphureous.* Schwach ſchweflich. Legerement ſulphureuſe. Sulphureus.

C. *Faintly bitter.* Schwach bitterlich. Legerement amer. Subamarus.

2. *Produced by breathing on it.* Nach dem anhauchen. En y portant la vapeur de l'expiration. Adflatu.

A. *Clay-like ſmell.* Thonigen geruch. Argilleuſe. Argilloſus.

3. *Excited by friction.* Durch reibung. Par la frottement. Frictione.

A. *Urinous.* Urinös. Urineuſe. Urinoſus.

B. *Sulphureous.* Schweflich. Sulphureuſe. Sulphuratus.

C. *Garlick-like, or arſenical.* Knoblauchartig. Ail. Alliaceus.

D. *Empyreumatic.* Empyreumatiſch. Empyreume. Empyreumaticus.

VIII. *The taſte.* Geſchmack. Saveur. Sapor. *The varieties are*

1. *Sweetiſh taſte.* Süſſalzig. Salée. Dulce ſalſus.

2. *Sweetiſh aſtringent.* Suſszuſamenziehend. Adſtringente.

3. *Styptic.* Herbe. Acerbe. Stypticus.

4. *Saltly bitter.* Salzigbitter. Salée amere. Salſo-amarus.

5. *Saltly cooling.* Salzigkühlend. Salée fraiche. Frigido-ſalſus.

6. *Alkaline.* Laugenhaft. Alcaline. Lixivioſus.

7. *Urinous.* Urinöſe. Urineuſe. Urinoſus.

END.

PLATE I.

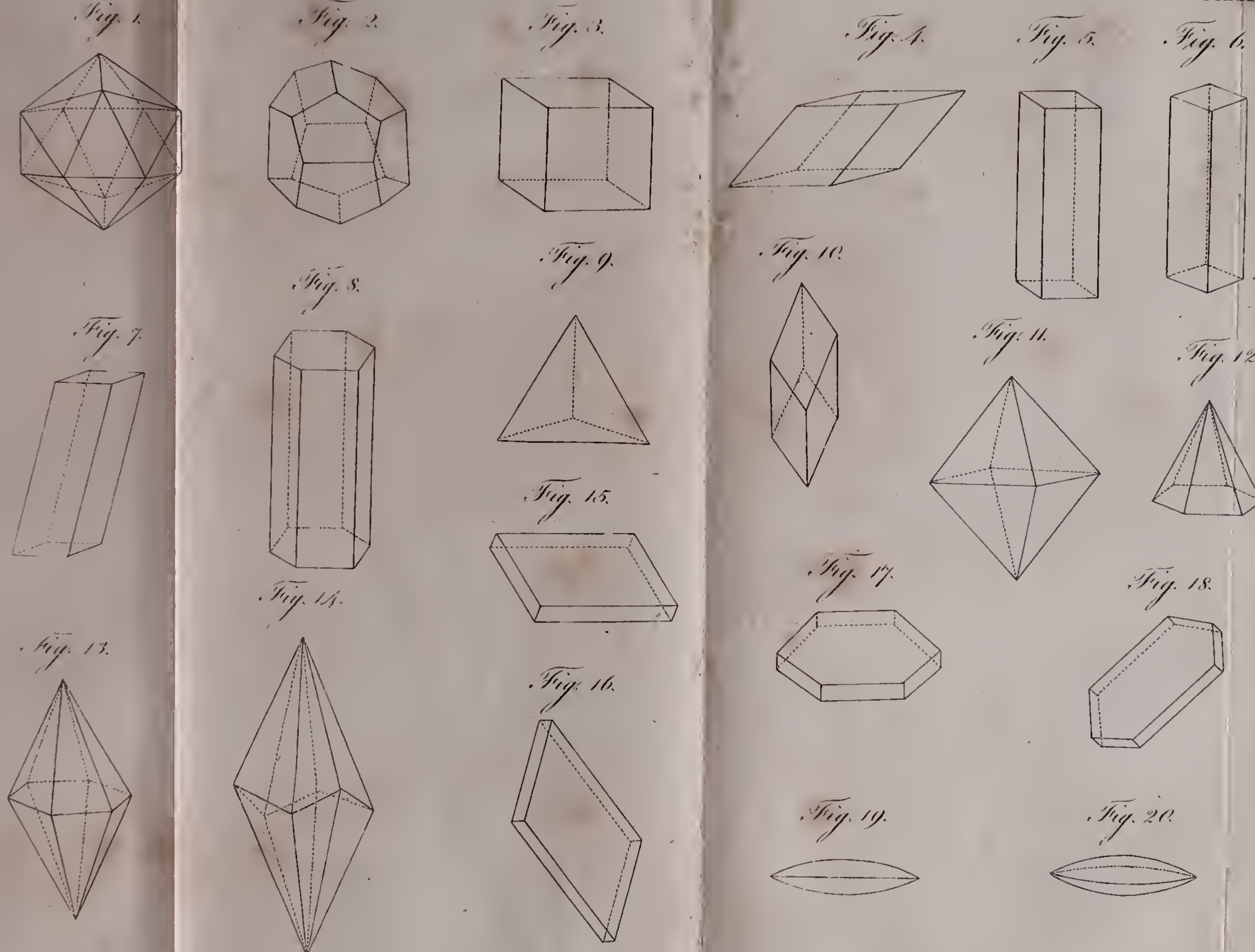
Fig. 1.
Fig. 2.
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Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
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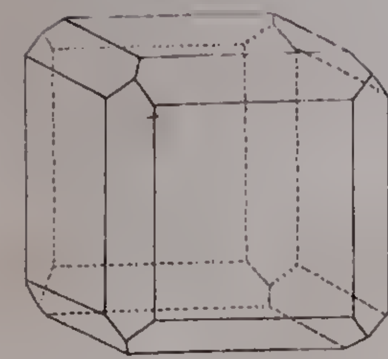
Fig. 18.
Fig. 19.
Fig. 20.

PLATE II.

Fig.

Fig. 22.



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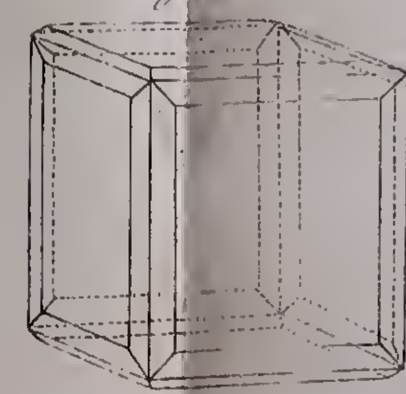

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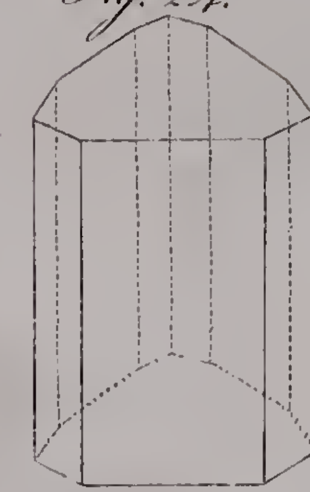
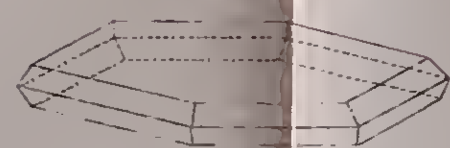


Fig. 25.

Fig. 26.



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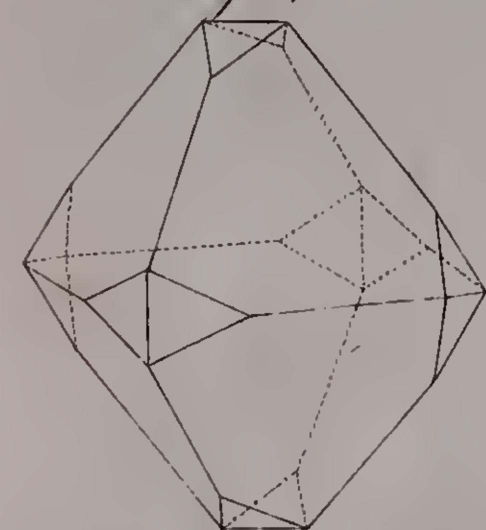

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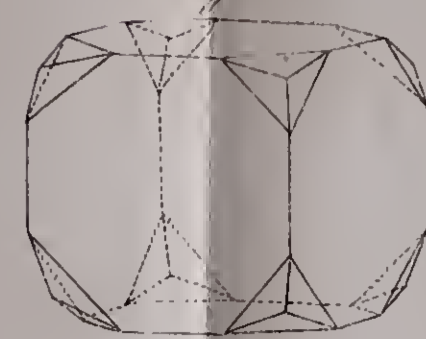

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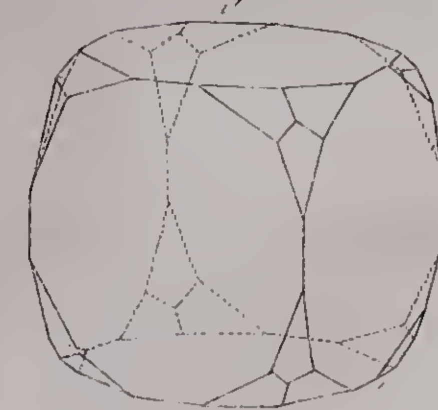

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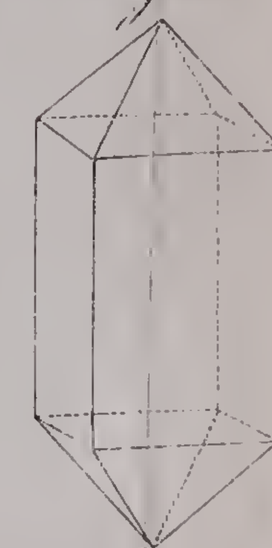

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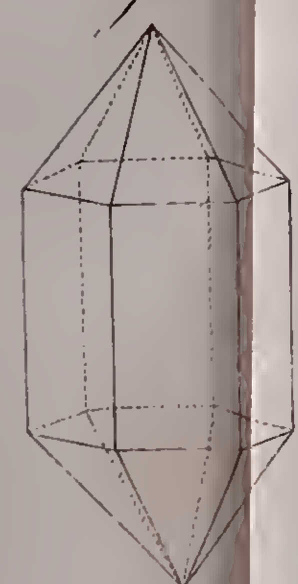

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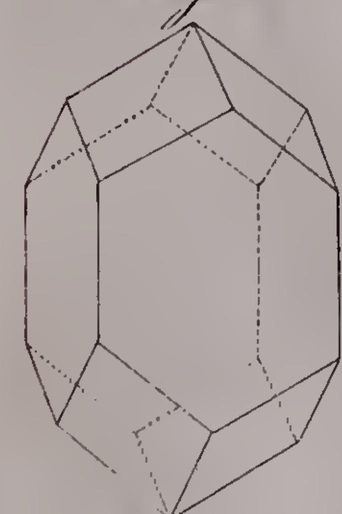

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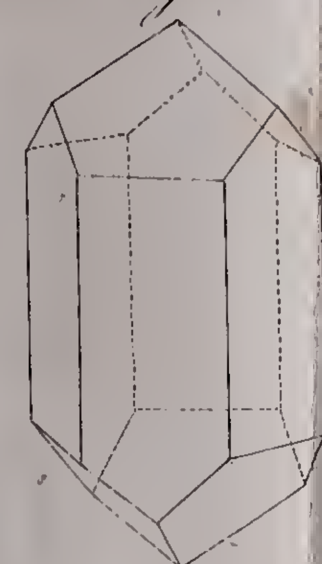

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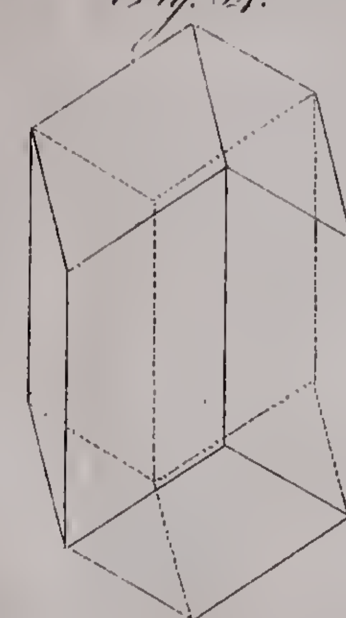

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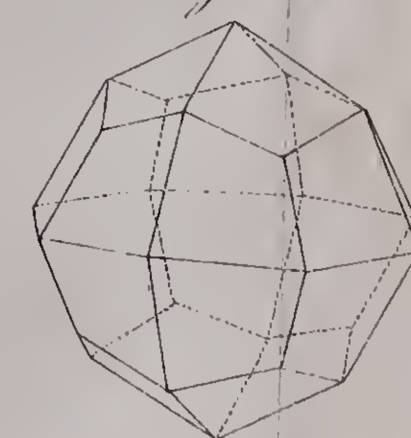

A
MINERALOGICAL DESCRIPTION
OF
SCOTLAND,
VOLUME I
PART I.
COUNTY OF DUMFRIES.


Map OF DUMFRIES Shire
Reduced from the Survey of the County made by WILLIAM CRAWFORD.
AYR SHIRE
LANARK SHIRE
PEEBLES SHIRE
SELKIRK SHIRE
ROXBURGH SHIRE
COUNTY OF KIRKCUDBRIGHT
CUMBERLAND
SOLWAY FRITH
NITHSDALE
ANNANDALE
ESKDALE
DUMFRIES
ANNAN
Corsoncone
Kirkconnel
Sanquhar
Elliock Bridge
Leadhills
Wanlock head
Lowthers
Durisdeer
Drumlanrig
Carron Water
Morton
Thornhill
Penpont
Tynron
Keir
Closeburn
Glencairn
Barjarg
Brownhill Inn
River Nith
Dunscore
Kirkmahoe
Holywood
Tinwald
Torthorwald
Kirkmichael
Water of Ae
Queensberry Hill
Loch Skene
Hartfell
Hartfell Spa
Moffat
Moffat Water
Kirkpatrick juxta
Annan River
Wamphray
Johnston
Hutton
Dryfe Water
Applegarth
Lochmaben
Dryfesdale
Lockerby
Tundergarth
Burnswark
Water of Milk
St. Mungo
Middlebie
Whinny rig
Dalton
Ecclefechan
Mein Water
Repentance
Brown Muir Hill
Mousewald
Longrobie
Wood Cockair
Ruthwell
Cummertrees
Caerlaverock
C. Castle
Criffel
Crags
Lochar Water
Hill
Dornock
Kirkpatrick fleming
Graitney
Kirtle Water
Sark Water
Halthmorton
Canobie
Liddel River
River Esk
Longtown
Broomholm
Wauchope Water
Langholm
Lodge
Westerkirk
Ewes
Eskdale Muir
Etrick Pen
Maryport
CARLISLE

A

MINERALOGICAL DESCRIPTION

OF THE

COUNTY OF DUMFRIES.

Patrick —— Murray S. o. f.

By ROBERT JAMESON,

GIUS PROFESSOR OF NATURAL HISTORY, AND KEEPER OF THE MUSEUM IN THE UNIVERSITY OF EDINBURGH; FELLOW OF THE ROYAL AND ANTIQUARIAN SOCIETIES OF EDINBURGH, OF THE LINNÆAN SOCIETY OF LONDON; HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, OF THE MINERALOGICAL AND PHYSICAL SOCIETIES OF JENA, ETC.

EDINBURGH:

Printed at the University Press;

FOR BELL & BRADFUTE, AND W. BLACKWOOD;

AND

LONGMAN, HURST, REES, AND ORME,

LONDON.

1805.

TO

A. G. WERNER,

THE FATHER OF MINERALOGY;

AND

RICHARD KIRWAN,

WHOSE INDEFATIGABLE EXERTIONS HAVE CONTRIBUTED SO GREATLY TO THE ADVANCEMENT OF MINERALOGY IN THE BRITISH EMPIRE.

THIS VOLUME

IS DEDICATED BY THEIR OBEDIENT SERVANT,

ROBERT JAMESON.

College of Edinburgh,
Oct. 10, 1804.

ERRATA.

Page	Line	
17	8	that *to be cancelled.*
58		*for* druffy, *read* drufy.
154	2	*after* in, *add* engen Räumen eingefchloffen war, wodurch ihr,

PREFACE.

The Duke of Buccleugh, with his uſual patriotic attention to the intereſts of Dumfries-ſhire, propoſed ſome years ago to the landholders of the county to have a Map of it made for their uſe; and, with the approbation of his Grace, Colonel, now Brigadier-General Dirom of Mount Annan, ſuggeſted that a Mineral ſurvey ſhould alſo be made of the county, in order to connect a knowledge of its foſſils and internal ſtructure with the land ſurvey which was then carrying on by Mr. William Crawford.

"The meeting unanimouſly approved "of the propoſal for the mineral ſurvey, "and voted their thanks to his Grace the "Duke of Buccleugh for having been "pleaſed to recommend it to their atten-"tion; and to Colonel Dirom for having "brought forward a plan ſo likely to be "uſeful to the county."

Upon that occaſion I was applied to by the General and by Colonel Wight of Largnain, on the part of the county, to undertake the mineral ſurvey; but, being on the eve of my departure for Germany, I was under the neceſſity of declining to enter upon ſuch an inveſtigation. It being, however, the principal object of the gentlemen of the county to obtain information as to the probability of finding coal in the extenſive tract of country which lies between the rivers Eſk and Nith, they engaged two *coal viewers* from Northumberland, Meſſrs. Buſby, to make the ſurvey, to whom, both the late Dr. Walker, my predeceſſor in the chair of natural hiſtory, and myſelf, gave inſtructions, which, together with their report, are, I underſtand, in the poſſeſſion of the county.

Previous to my return from Germany, General Dirom had prepared a Tablet, containing ſections, and exhibiting a general view of the Mineralogy of Dumfries-ſhire, to be printed on the map of the county, and which, in a ſmall compaſs, contains much uſeful and intereſting information. But, as both the General and Colonel Wight confidered what had been done as ftill not affording the complete information which was expected by the landholders of the county, upon this important fubject, I was again requefted by thefe intelligent gentlemen to undertake the publication of a more detailed mineralogical defcription of Dumfries-fhire, which might accompany the county map, which was ftill unpublifhed. To this propofal I acceded with pleafure, not only from my defire to promote fuch ufeful inveftigations, but alfo from its tending to carry into effect a plan which I had long in contemplation, of examining the mineralogy of every part of Scotland, and of offering, in this manner, the refult of my labours for the information of the public.

INTRODUCTION.

In a country like Scotland, whofe furface prefents fo great a variety of rocks, and which agrees in many refpects with the moft important mining countries in other parts of the world, it is evident that many confiderable mineral repofitories are to be expected. Its fituation, the ftructure of its furface, and the abundance of water and coal which it poffeffes, render it peculiarly well adapted for carrying on with œconomy and profit the various operations of mining.

But as ores, coals, and other ufeful minerals are ufually hid in the bowels of the earth, we muft endeavour by mining to trace them out; and in theſe reſearches we muſt follow a determinate plan, founded on an accurate local knowledge of the diſtrict where the trials are made; otherwiſe in excavating galleries, driving levels, ſinking ſhafts, and putting down bore-holes, our operations will be uncertain.

Theſe operations muſt be conducted with ſkill, and their execution ſhould be ſuperintended by well educated and intelligent mine-engineers.

It is an opinion too generally credited, that the art of mining is eaſy and ſimple, and that little education, and no very great ſhare of practical knowledge is neceſſary for its ſucceſsful proſecution. But this aſſertion is founded on ignorance; for of all the arts with which man is occupied, there is none which requires more preliminary knowledge or more extenſive experience. A *mine engineer* muſt be well inſtructed in ſubterranean geometry; he muſt be intimately acquainted with mechanics, hydraulics, and hydroſtatics, ſo that he may be able to judge correctly of the machines which are employed in conveying the ores from one part of a mine to the other, raiſing them to the ſurface, and ſtamping and waſhing them, alſo with the elegant and powerful machines uſed in draining mines; he muſt poſſeſs as much knowledge of architecture as will enable him to ſuperintend the conſtruction of the various kinds of building which are employed in ſubterranean works, and in the erection of the different day buildings, as engine, ſmelting, and waſhing houſes, and alſo that of canals, artificial reſervoirs for water, &c.; nor ſhould he be ignorant of the art of carpentry, particularly that ſpecies of it which is employed in conſtructing ſubterranean works. His knowledge of mineralogy muſt be correct and extenſive, in order to enable him to know and diſtinguiſh ſimple minerals, and to judge with accuracy of the various mineral repofitories ; he muft be acquainted with all the branches of chemiftry, but moft particularly with that of metallurgy; and he muft not be indebted to lectures, books, drawings, and models alone for his knowledge ; he muft have affifted for years in all the practices I have juft mentioned. When this courfe of education is finifhed, he fhould be able confcientioufly to take charge of a great mine, or to eftablifh one in a country where there are few to affift him with knowledge or experience.

I could mention very many inftances of the great lofs to proprietors and ftates by the want of fkill and experience in mine-engineers, but I fhall at prefent mention only one, and it is very ftriking. In Spanifh America, according to Anton Zacharias Helms, the amalgamation of the ore continues an entire month, and in each operation there is a lofs of twenty-five pounds of mercury in the quintal, and a part of the filver remains in the ore. At Freyberg the operation is finifh- in twenty-four hours, the lofs of mercury does not exceed half an ounce, and a fmall quantity of filver is obtained which was not even indicated in the cupellation of the effayer. Daubiffon, a diftinguifh-ed pupil of Werner, in his mafterly def-cription of the mines of Freyberg, infers very juftly from this fact that the pro-duce of the Spanifh American mines might be greatly increafed, nay nearly doubled *.

* As it may be interefting to fome of my readers to know the actual produce of thefe famous mines, I here fubjoin an extract from the work of Daubiffon already mentioned, containing an account of the re-turns made to the Spanifh mint, in the year 1790.

Cities.	*Provinces.*	*In gold.* *Livres.*	*In filver.* *Livres.*
a. St. Jago	Chili	4,417,134	894,327
b. Potofi	Buenos-Ayres	1,833,728	24,367,668
c. Lima	Peru	5,023,616	27,768,000
d. Mexico	Mexico	3,843,629	106,706,140
		15,118,107	159,736,135

But independent of the employment which the refearches I am now engaged in will afford to the miner, by the difcovery of ufeful minerals, it will, I truft, alfo prove a fource of information to the mineralogift. Few countries fo little explored as Scotland have afforded a greater variety of minerals, which allows us to hope that a more complete and accurate inveftigation will increafe the number of hitherto undefcribed oryctognoftic products. The geognoft *, will obtain new facts, and

To this fum, amounting to one hundred and feven-four million of livres, may be added the quantity of gold and filver not delivered to the mint, but which is worked for churches, convents, and other ufes, which is very confiderable. Thus we may reckon that there is annually raifed from the mines of Spanifh America the value of two hundred million livres, or fifty million rix-dollars.

* Geognofie not only makes us acquainted with the materials and ftructure of the cruft of the earth, but alfo with the hiftory of the changes which it has experienced, thus forming a moft interefting branch

a more extenfive generalization of thofe already known refpecting the ftructure and relative pofition of the maffes of which the earth is compofed, by an examination of the unexplored wilds of Scotland.

In the Mineralogical Defcription of the County of Dumfries, which forms the firft part of this volume, I have laid down

of *Natural Hiftory*. But it is not confined to the hiftory of the changes which the inorganic parts of the globe have undergone; it alfo developes thofe numerous and wonderful alterations which the organic creation has experienced fince it was firft formed by the creator. Taken in this view, geognofie ceafes to be that unconnected, vague, and ufelefs jargon which it was before the time of Werner; it is thus raifed to the rank of the moft important and interefting of the fciences. It unites all the branches of natural hiftory, (I mean natural hiftory commonly fo called, which includes natural defcription and the hiftory of natural bodies,) and forms the link which connects the inveftigations of the naturalift with thofe of the aftronomer, the one being employed in inveftigating the ftructure of the world, the other that of the univerfe.

the plan I intend to follow in all my future labours in this department of mineralogy. It is different from any hitherto propofed, but from its concordance with the principles of the Wernerian geognofie I truft it will be found calculated to give a clear, diftinct, and comprehenfive view of the external afpect and internal ftructure and materials of which a country is compofed.

The Defcription of Dumfries-fhire, which I now prefume to lay before the public, is not fo complete as to fatisfy a well informed mineralogift; I truft, however, that although incomplete it will be found accurate. The obfervations which it contains, confidered in an œconomical point of view, fhew that many extenfive tracts of the independent coal formation exift in different parts of the county; that limeftone may exift in many places where it has not been hitherto expected; that from the fhape of the mountains in the upper part of the county, and the kind of rock of which they are compofed, mineral repofitories of different kinds, but particularly of lead ore, are to be expected; and that roof flate will be found in many parts of the tranfition country.

The geognoftical obfervations make us acquainted, 1. With an extenfive tract of tranfition rocks, a clafs of rocks hitherto unnoticed in Great Britain *.

* I have traced the tranfition rocks from the northern extremity of the Pentland hills, which is about fix miles diftant from the fhore of the firth of Forth, to Lang-robie in Dumfries-fhire, about three miles from the Solway frith. The fame clafs of rocks reaches from Langholm to Minihive, and at length terminates near New Galloway, where it is fucceeded by primitive rocks. The Moorfoot hills near Edinburgh, which form one of the boundaries of the great coal field of the Lothians, are compofed of tranfition rocks; and I have every reafon to believe that thefe rocks continue nearly to the termination of the mountain range at St. Abb's head on the eaft coaft. Granite is faid to have been found at Faffnet burn, which is in the tract I confider

2. With a lead glance formation different from any defcribed by Werner or any other geognoft. 3. With a formation of pitchftone, refembling that of the ifland of Arran, which belongs to the neweft floetz-trap formation. 4. With a coal formation which refembles in many refpects the old red fandftone, but which is moft diftinctly different as a formation. 5. With the occurrence of glance coal in the independent coal formation, and with a new fubfpecies called *columnar glance coal.*

In the Notes and Illuftrations there is a particular account of the occurrence of

to be tranfition. I fuppofe fyenitic greenftone has been confounded with granite.

Since writing the above, I have examined a fuite of fpecimens brought from Faffnet burn and the neighbourhood of St. Abb's head by Dr. Hope, and find my conjecture, refpecting the extent of the tranfition rocks, and the nature of the fuppofed granite of Faffnet, confirmed.

greenſtone in the independent coal formation, a diſcovery which ſupplies a link hitherto wanting in the Wernerian trap formation ſuite, and which ſhews that there is floetz-trap of different ages; and with a new graphite formation which differs from that hitherto known in its accompanying foſſils and rocks, and in its geognoſtic ſituation.